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ABSTRACT

This curriculum guide provides materials for the industrial arts (grades 7-9) subject cluster of manufacturing. This subject cluster has four areas of study: metalwork, plastics, woodwork, and manufacturing. Introductory materials include an overview of the industrial arts curriculum in its entirety, a listing of program objectives for each of the four areas of study, and information on curriculum implementation. The three core modules common to each area of study (student orientation, safety, and careers) are treated in a general way in a separate section, and more specifically with the four subject areas. The next four sections contain the core and optional modules for the four areas. Each of the modules includes the following: major objective, student objectives, suggested activities and notes, and resources. All four areas have modules on these topics: student orientation, safety, careers, measurement, design and construction, consumerism, materials, separation, forming, fastening, finishing, jigs and fixtures, mass production, and enterprise system. In addition, two areas of study--metalwork and manufacturing--include a module on conditioning. A bibliography of 47 columns concludes the guide, including references to texts, reference and professional books, periodicals, law statutes, and especially audiovisual materials, arranged by the four topics. (YLB)

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industrial arts 7-9
manufacturing

metalwork
plastics
woodwork
manufacturing

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The guides for the Industrial Arts 7-9 subject clusters (Construction, Graphic Communications, Power/Energy, and Manufacturing) replace the 1969 Industrial Arts Teacher's Guide for grades seven, eight, and nine; and the interim guides for Construction, Graphic Communications, Power/Energy, and Manufacturing issued in 1976. They have been developed as part of the overall revision of the industrial arts programs for the junior high schools of Manitoba. They are based on recommendations included in the Report of the Home Economics and Industrial Arts Task Force of 1978 and Education for the Middle Years, a 1977 position paper of the Middle Years Program Review Committee, as well as on suggestions from junior high school and community college teachers.

Industrial Arts 7-9: Manufacturing (1984) becomes the approved provincial guide for industrial arts in the junior high school, effective the fall of 1984.

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OVERVIEW

INTRODUCTION

The junior high school industrial arts curriculum has been revised to reflect the philosophy of the Middle Years Program Review Committee, and to provide objectives and learning experiences which will enable students to maximize their effectiveness as individuals within the family, business, and community. The focus is on the well-being of individuals, groups, and businesses/industries, on the environmental qualities which affect that well-being, and on how individuals and industry in turn affect the environment.

The Middle Years Program Review Committee and the Home Economics and Industrial Arts Task Force have recommended that the curriculum:

1. de-emphasize sex bias in roles and expectations normally assigned to home economics and industrial arts programs;
2. minimize the sequencing of courses to enable students to participate in a wide variety of learning experiences, by providing an exploratory program, particularly at the introductory level.

A combined home economics/industrial arts exploratory program, at the introductory level, will be available.

The curriculum also reflects the effects of a rapidly changing society, awareness of many forms of industry and industrial processes, and social and technological changes which influence life styles and business/industry.

This guide should assist teachers in meeting students' physical, social, emotional, and intellectual needs through the emphases on the continuing responsibilities of individuals and groups, and on the processes by which decisions are made and action is taken. This guide provides student objectives, suggested activities, notes, and resources to assist teachers in planning programs related to their students and community.

RATIONALE

The study of industrial arts in the junior high school program in Manitoba is designed to help students clarify values, set personal goals, and acquire skills for improving the quality of life for individuals and groups in business, industry, community, and society.

Industrial arts has much to contribute to the growth and development of students in the middle years and to the curriculum of the middle years school. Industrial arts helps emerging and early adolescents in their search for identity and development of self-concept; encourages the development of such basic skills as learning how to learn and making decisions; encourages the development of skills in personal and family life and in business and industrial processes; explores possible career choices in industrial-arts related areas; and provides opportunities for students to discover new interests, growing capacities and the need for effective use and control of resources and technologies.

The study of industrial arts will enable students to:

1. Appreciate the interdependence of the individual, the family, and groups in business/industry and society, and understand the factors in society, business/industry, and the community which assist individuals in meeting basic needs.

2. Understand the influences which affect decision-making and realize that one can use natural and industrial resources effectively in making choices which are satisfying and accountable to self, family, groups, business/industry, and community.

3. Identify values and priorities in life and consider the quality of life as much as the quantity of production and consumption.

4. Understand the ways in which an individual, alone or as part of a group, can increase opportunities to achieve potential and satisfaction in life.

5. Appreciate good craftsmanship and design, both in the products of modern industry and in artifacts from past cultures.

6. Understand the necessity to adjust and adapt in a world of change.

7. Develop knowledge and skills to improve human relations and to meet present and future needs of society.

8. Appreciate the interdependence and the importance of practicing the management skills of planning, organizing, and controlling work.

9. Develop critical thinking related to materials, tools, and processes of industry, and creative expression related to industrial materials.

10. Recognize the importance of safety in the use and maintenance of tools, energy, equipment, and materials appropriate to various technologies in a productive society.

11. Develop positive attitudes towards safety, conservation, ecology, and technology.

12. Recognize consumer rights and responsibilities relating to self and to various types of industries.

13. Understand and recognize the vocations and general occupational characteristics of various types of industries.

14. Recognize the relationship of personal interests, abilities, preferences, and values to various career areas.

THE DEVELOPMENTAL STAGES OF ADOLESCENTS

The content of the industrial arts programs is closely related to adolescent developmental stages. The adolescent years are a period of transition, and within this period students' development varies widely.

An outline of typical characteristics of junior high students has been used as a guide in creating, adapting, and suggesting learning experiences. Characteristics of adolescents may be described under the headings: cognitive, physical, emotional, social, and moral. All aspects of development are interconnected.

ADOLESCENT NEEDS	CHARACTERISTICS	APPROPRIATE ACTIVITIES
Cognitive: Develop intellectual activity which is logical and abstract, with thinking becoming more mobile, flexible and less egocentric.	Interested primarily in self, but gradually developing greater interest in the outside world and in family problems.	Begin with interests and concerns, then proceed to family, community and society. The 12-year-old is concerned with lack of resources. Begin with this problem and proceed to a discussion of family resources, then to resources in industries and in the community.
Physical: Develop one's physique and use the body effectively.	A physical age with tremendous variations.	Discuss the role of the individual, family, and business in meeting physical needs.
	Growth makes demands on energy.	Emphasize nutritious foods for growth and development required to learn and work effectively.
	Growth affects self-concept.	Encourage participation in projects to promote personal satisfaction and creativity.
	Concern with awkwardness and physical appearance.	Identify and discuss factors which affect personal appearance and safety in a work environment.
	Experience difficulty in carrying out long-range projects. May be restless with short attention span.	Provide variety in content and methods. Work on projects that can be completed in a short period of time or completed in sections. Encourage active participation in learning.

ADOLESCENT NEEDS	CHARACTERISTICS	APPROPRIATE ACTIVITIES
Emotional: Emotional needs are closely linked to physical needs.	Variable and intense.	Help students recognize that changes in their development affect behavior.
	Great stresses and contrasts.	
	Need to come to terms with emotions.	
	Inclined to be enthusiastic and often impulsive.	Create an atmosphere for tapping enthusiasm and impulse with techniques such as brainstorming, ad lib skits, word association, self-chosen projects and assignments.
Achieve emotional independence of parents and other adults.	Seeking identity.	Encourage students to identify individual strengths that lead to a greater understanding and acceptance of self.
Social: Desire and achieve socially responsible behavior.	Relationship with peers important.	Contrast activities and relationships with peers and family.
	Group oriented, but conflict between group and individuality.	Provide opportunities to work individually and in groups.
	Increasing maturity.	Help students to appreciate that each person is different physically and mentally, possessing characteristics which make one worthy of acceptance.
	Rise of sexuality and relationships with opposite sex.	

ADOLESCENT NEEDS	CHARACTERISTICS	APPROPRIATE ACTIVITIES
Moral: Acquire a set of values and an ethical system as a guide to behavior.	Live primarily in the present, now rather than tomorrow, but gradually growing more concerned with immediate and distant future. Social and intellectual development have important consequences for moral growth. Make personal evaluations. Begin to formulate own moral code. Less inclined to accept parental values. Begin to put self in another's place.	Build on present interests and concerns.

STRUCTURE OF THE PROGRAM

The Industrial Arts curriculum for grades seven, eight, and nine is divided into subject clusters, areas of study, and modules, rather than by grade designation. The division and the depth of content and objectives for each area of study in each grade level, will depend upon laboratories available, the time allotment, and the organization of the program in a school. Curriculum content proceeds from the establishment of basic understanding and skills at the introductory level, to a more intensive study and understanding at subsequent levels.

There are four subject clusters: Construction, Graphic Communications, Power/Energy, Manufacturing. Each subject cluster contains areas of study. Construction has one area of study: Construction; Graphic Communications has three areas of study: Drafting, Graphic Arts, Graphic Communications; Power/Energy has three areas of study: Electricity/Electronics, Power Mechanics, Power/Energy; and Manufacturing has four areas of study: Metalwork, Plastics, Woodwork, and Manufacturing. Each area of study is comprised of core modules (C) or core and optional (O) modules. Three of the core modules, Student Orientation, Safety, and Careers, are common to all areas of study.

The subject cluster for Construction comprises 16 core and 5 optional modules.

Construction

I Student Orientation (C)
II Safety (C)
III Careers (C)
IV Measurement (C)
V Planning and Design (C)
VI Consumerism (C)
VII Site Selection (C)
VIII Materials (C)
IX Separation (C)
X Fastening (C)
XI Footings and Foundations (C)
XII Floors (C)
XIII Walls and Partitions (C)
XIV Roofs (C)
XV Enclosing (C)
XVI Energy and Insulation (C)
XVII Exterior Finish (O)
XVIII Interior Finish and Trim (O)
XIX Plumbing System (O)
XX Electricity (O)
XXI Landscaping (O)

The Graphic Communications subject cluster includes 13 core modules for Drafting, 14 core and 3 optional modules for Graphic Arts, and 19 core and 3 optional modules for Graphic Communications.

	Drafting	Graphic Arts	Graphic Communications
I	Student Orientation (C)	Student Orientation (C)	Student Orientation (C)
II	Safety (C)	Safety (C)	Safety (C)
III	Careers (C)	Careers (C)	Careers (C)
IV	Measurement (C)	Measurement (C)	Measurement (C)
V	Planning and Design (C)	Planning and Design (C)	Planning and Design (C)
VI	Consumerism (C)	Consumerism (C)	Consumerism (C)
VII	Sketching (C)	Design Concepts (C)	Sketching (C)
VIII	Mechanics of Drawing (C)	Screen Process (C)	Mechanics of Drawing (C)
IX	Pictorial Drawing (C)	Relief Printing (C)	Pictorial Drawing (C)
X	Orthographic Drawing (C)	Black and White Photography (C)	Orthographic Drawing (C)
XI	Drawing Interpretation (C)	Process Photography (C)	Drawing Interpretation (C)
XII	Drawing Reproduction (C)	Planographic Printing (C)	Design Concepts (C)
XIII	Electronic Systems (C)	Intaglio Printing (C)	Screen Process (C)
XIV		Packaging and Presentation (C)	Relief Printing (C)

	Drafting	Graphic Arts	Graphic Communications
XV		Color Photography (O)	Black and White Photography (C)
XVI		Office Graphic Arts Equipment (O)	Process Photography (C)
XVII		Electronic Systems (O)	Planographic Printing (C)
XVIII			Intaglio Printing (C)
XIX			Packaging and Presentation (C)
XX			Color Photography (O)
XXI			Office Graphic Arts Equipment (O)
XXII			Electronic Systems (O)

The Power/Energy subject cluster includes 13 core modules for Electricity/Electronics, 11 core modules for Power Mechanics, and 11 core modules for Power/Energy.

	Electricity/Electronics	Power Mechanics	Power/Energy
I	Student Orientation (C)	Student Orientation (C)	Student Orientation (C)
II	Safety (C)	Safety (C)	Safety (C)
III	Careers (C)	Careers (C)	Careers (C)
IV	Measurement (C)	Measurement (C)	Measurement (C)
V	Planning and Design (C)	Planning and Design (C)	Planning and Design (C)
VI	Consumerism (C)	Consumerism (C)	Consumerism (C)
VII	Components (C)	Tools and Fasteners (C)	Tools and Fasteners (C)
VIII	Tools and Fasteners (C)	Energy Sources (C)	Energy Sources (C)
IX	Energy Sources (C)	Energy Conversion (C)	Energy Conversion (C)
X	Energy Conversion (C)	Transmission of Power (C)	Transmission of Power and Energy (C)
XI	Energy Transmission (C)	Routine Care and Maintenance (C)	Power Systems (C)
XII	Energy Systems (C)		
XIII	Electrical Wiring (C)		

The Manufacturing subject cluster includes 15 core modules for Metalwork, 14 core modules for Plastics, 14 core modules for Woodwork, and 15 core modules for Manufacturing.

	Metalwork	**Plastics**	**Woodwork**	**Manufacturing**
I	Student Orientation (C)	Student Orientation (C)	Student Orientation (C)	Student Orientation (C)
II	Safety (C)	Safety (C)	Safety (C)	Safety (C)
III	Careers (C)	Careers (C)	Careers (C)	Careers (C)
IV	Measurement (C)	Measurement (C)	Measurement (C)	Measurement (C)
V	Design and Construction (C)	Design and Construction (C)	Design and Construction (C)	Design and Construction (C)
VI	Consumerism (C)	Consumerism (C)	Consumerism (C)	Consumerism (C)
VII	Materials (C)	Materials (C)	Materials (C)	Materials (C)
VIII	Separation (C)	Separation (C)	Separation (C)	Separation (C)
IX	Forming (C)	Forming (C)	Forming (C)	Forming (C)
X	Conditioning (C)	Fastening (C)	Fastening (C)	Conditioning (C)
XI	Fastening (C)	Finishing (C)	Finishing (C)	Fastening (C)
XII	Finishing (C)	Jigs and Fixtures (C)	Jigs and Fixtures (C)	Finishing (C)
XIII	Jigs and Fixtures (C)	Mass Production (C)	Mass Production (C)	Jigs and Fixtures (C)
XIV	Mass Production (C)	Enterprise System (C)	Enterprise System (C)	Mass Production (C)
XV	Enterprise System (C)			Enterprise System (C)

Each of the modules for the 11 areas of study includes the following:

1. Major objectives accompany each module and provide an overview of what the student should achieve through the study of the module.

2. Student objectives are related to topics and are sequenced to lead to an understanding of the major objective. The objectives are based on students' needs and average abilities. Learning one objective leads to insight into how to proceed to the next objective, and, eventually, to understanding of the major objective and the topics. If students are aware of the objectives, they may identify with them more closely and aim to achieve them.

3. Suggested activities and notes are designed to help students achieve objectives. These experiences help the students to acquire knowledge, learn skills, evaluate attitudes and values, and develop understanding, appreciation, and perception of topics and objectives. The learning experiences and activities should be added to and updated continually by the teacher and the students.

4. Resources are suggested to assist the teachers and the students in developing and understanding the topics, objectives, and learning experiences. The resources should be added to and updated continually by the teacher and the students.

PROGRAM GOALS

The general goals of the junior high industrial arts program are to assist students to:

- acquire an understanding of self.
- understand how personal, business, industrial, and societal needs are met through positive interrelationships.
- develop skills to meet needs in the home, in the community, and in business and industry.
- develop a high degree of safety consciousness.
- acquire basic skills in the use of common industrial tools, machines, and processes.
- become increasingly questioning, creative, and critical consumers of natural and industrial resources and accept responsibilities for decisions made.
- develop problem-solving and creative abilities involving materials, processes, and products of industry.
- become involved in energy-saving, ecology, conservation, and technological studies and activities.
- develop confidence, high standards of performance, and a sense of pride in achievement.
- discover and develop talents, aptitudes, interests, and potential in technical fields and applied sciences.
- acquire basic skills and knowledge related to materials and technical procedures.
- gain an insight into various types of industries and their relationship to individuals, communities, society, and economic systems and conditions.
- develop creative potential, both avocationally and vocationally.
- achieve a degree of competency that leads to further education, training, and employment.
- acquire an understanding of the relationship between technological advances, requirements of industry, careers, and economic conditions.
- develop skills to make choices leading toward the attainment of a better quality of life.

PROGRAM OBJECTIVES

The classifications of educational objectives--psychomotor, affective, and cognitive--have a relationship to each other. Frequently, at least two, if not all three, types of learning occur simultaneously. The teacher may choose to concentrate on one objective at a time or to correlate two or more objectives. It is possible to incorporate all three types of objectives as components of behavior or action. The student may be developing a skill and at the same time acquiring an attitude or value as well as a knowledge of principles related to the skill.

MAJOR OBJECTIVES: METALWORK

This area of study is designed to aid beginning students to explore the science, knowledge, processes, and skills related to metalwork and to understand its relationship to individuals, society, safety, careers, consumerism, conservation, industry, economy, technology, and to progress in standards of living in different nations. This study develops understanding, decision-making capability, and basic skills in the selection, use, and maintenance of materials, tools, and equipment. It provides opportunities to apply knowledge, principles, and skills to techniques and processes pertinent to design, production, and distribution of relevant products and services. Study in this area can lead to present and future educational, vocational, and avocational skills; to appreciation of high standards of workmanship and the dignity of work; and to investigation and solution of technical and sociological problems related to metalwork.

The student should be able to:

- Explore the relationship of industrial arts to the needs of individuals, industry, and society.

- Develop safety consciousness in the use of tools, machines, and processes, through a wide range of experiences related to the individual and to the production and servicing aspects of hobbies and industries in metalwork.
- Gain information about the general occupational characteristics of a variety of career fields and match interests, abilities, likes, dislikes, and values to characteristics of various careers.
- Procure knowledge and skills related to imperial and SI metric systems of measurement and measuring devices, and apply the knowledge and skills to measurement activities and problems pertinent to metalwork.
- Obtain knowledge and skills related to the principles of planning and design and apply the knowledge and skills to plan, design, and construct metalwork projects and products.
- Explore the economic system and the economy in relation to metalwork and consumer awareness.
- Acquire information about the nature, source, classification, processing, and properties of metals and, apply this information to metalwork projects and products.
- Obtain knowledge and skills related to the separation processes and to the use, care, and maintenance of hand and power tools applicable to these processes in metalwork.
- Gain knowledge and skills related to forming and to the use, care and maintenance of tools and equipment applicable to various forming processes in metalwork.
- Recognize the significance and gain understanding of the common methods of conditioning and apply this understanding to various conditioning processes in metalwork.
- Obtain knowledge and skills related to the methods, tools, equipment, and materials applicable to mechanical, adhesion, and cohesion fastening procedures in metalwork.
- Acquire information and skills related to a number of finishing processes in metalwork and perform these processes using tools and equipment with increasing accuracy.
- Recognize the significance of jigs and fixtures, gaining knowledge and skills related to designing, constructing, testing, and refining jigs and fixtures for use in manufacturing metalwork products.
- Gain an understanding of the principles and influence of mass production; explain the essential elements of industry; describe the basic steps in manufacturing product parts and in planning a manufacturing system of mass production; and apply the principles and procedures to mass production of products/projects.
- Develop an understanding of the enterprise system, the various business organizations and their importance to industrial production, the divisions of an industrial organization, the role of management in corporations, and the way corporations are established.

MAJOR OBJECTIVES: PLASTICS

This area of study is designed to aid beginning students to explore the science, knowledge, processes, and skills related to plastics and to understand its relationship to individuals, society, safety, careers, consumerism, conservation, industry, economy, technology, and progress in standards of living in different nations. This study develops understanding, decision-making capability, and basic skills in the selection, use and maintenance of materials, tools and equipment. It provides opportunities to apply knowledge, principles, and skills to techniques and processes pertinent to design, production, and distribution of relevant products and services. Study of plastics can lead to present and future educational, vocational, and avocational skills; to appreciation of high standards of workmanship and the dignity of work; and to investigation and solution of technical and sociological problems related to plastics.

The student should be able to:

- Explore the relationship of industrial arts to the needs of individuals, industry, and society.
- Develop safety consciousness in the use of tools, machines, and processes, through a wide range of experiences related to the individual and to the production and servicing aspects of hobbies and industries in plastics.
- Gain information about the general occuptional characteristics of a variety of career fields and match interests, abilities, likes, dislikes, and values to characteristics of various careers.
- Procure knowledge and skills related to imperial and SI metric systems of measurement and measuring devices and apply the knowledge and skills to measurement activities and problems pertinent to work in plastics.
- Obtain knowledge and skills related to the principles of planning and design and apply the knowledge and skills to plan, design, and construct plastics projects and products.
- Explore the economic system and the economy in relation to plastics and consumer awareness.
- Acquire information about the nature, source, classification, processing, and properties of plastics, and apply this information to plastics projects and products.
- Obtain knowledge and skills related to the separation process and to the use, care, and maintenance of hand and power tools applicable to these processes in plastics.
- Gain knowledge and skills related to forming and to the use, care, and maintenance of tools and equipment applicable to various forming processes in plastics.
- Obtain knowledge and skills related to the methods, tools, equipment, and materials applicable to mechanical, adhesion, and cohesion fastening procedures in plastics.
- Acquire information and skills related to a number of finishing processes in plastics and perform these processes using tools and equipment with increasing accuracy.
- Recognize the significance of jigs and fixtures, gaining knowledge and skills related to designing, constructing, testing, and refining jigs and fixtures for use in manufacturing plastics products.
- Gain an understanding of the principles and influence of mass production; explain the essential elements of industry; describe the basic steps in manufacturing product parts and in planning a manufacturing system of mass production; and apply the principles and procedures to mass production of products/projects.
- Develop an understanding of the enterprise system, the various business organizations and their importance to industrial production, the divisions of an industrial organization, the role of management in corporations, and the way corporations are established.

MAJOR OBJECTIVES: WOODWORK

This area of study is designed to aid beginning students to explore the science, knowledge, processes, and skills related to woodwork and to understand its relationship to individuals, society, safety, careers, consumerism, conservation, industry, economy, technology, and progress in standards of living in different nations. This study develops understanding, decision-making capability, and basic skills in the selection, use, and maintenance of materials, tools, and equipment. It provides opportunities to apply knowledge, principles, and skills to techniques and processes pertinent to design, production, and distribution of relevant products and services. Study in this area can lead to present and future educational, vocational, and avocational skills; to appreciation of high standards of workmanship and the dignity of work; and to investigation and solution of technical and sociological problems related to woodwork.

The student should be able to:

- Explore the relationship of industrial arts to the needs of individuals, industry, and society.
- Develop safety consciousness in the use of tools, machines, and processes, through a wide range of experiences related to the individual and to the production and servicing aspects of hobbies and industries in woodwork.

- Gain information about the general occupational characteristics of a variety of career fields and match interests, abilities, likes, dislikes, and values to characteristics of various careers.
- Procure knowledge and skills related to imperial and SI metric systems of measurement and measuring devices and apply the knowledge and skills to measurement activities and problems pertinent to woodwork.
- Obtain knowledge and skills related to the principles of planning and design and apply the knowledge and skills to plan, design, and construct woodwork projects and products.
- Explore the economic system and the economy in relation to woodwork and consumer awareness.
- Acquire information about the nature, source, classification, processing, and properties of woods, and apply this information to woodwork projects and products.
- Obtain knowledge and skills related to separation processes and to the use, care, and maintenance of hand and power tools applicable to these processes in woodwork.
- Gain knowledge and skills related to forming and to the use, care, and maintenance of tools and equipment applicable to various forming processes in woodwork.
- Obtain knowledge and skills related to the methods, tools, equipment, and materials applicable to mechanical and adhesion fastening procedures in woodwork.
- Acquire information and skills related to various finishing processes and perform these processes using tools and equipment with increasing accuracy.
- Recognize the significance of jigs and fixtures, gaining knowledge and skills related to designing, constructing, testing, and refining jigs and fixtures for use in manufacturing wood products.
- Gain an understanding of the principles and influence of mass production; explain the essential elements of industry; describe the basic steps in manufacturing product parts and in planning a manufacturing system of mass production; and apply the principles and procedures to mass production of products/projects.
- Develop an understanding of the enterprise system, the various business organizations and their importance to industrial production, the divisions of an industrial organization, the role of management in corporations, and the way corporations are established.

MAJOR OBJECTIVES: MANUFACTURING

This area of study is designed to aid beginning students to explore the science, knowledge, processes, and skills related to manufacturing and to understand its relationship to individuals, society, safety, careers, consumerism, conservation, industry, economics, technology, and progress in standards of living in different nations. This study develops understanding, decision-making capability, and basic skills in the selection, use, and maintenance of materials, tools, and equipment. It provides opportunities to apply knowledge, principles, and skills to techniques and processes pertinent to design, production, and distribution of relevant products and services. Study in this area can lead to present and future educational, vocational, and avocational skills; to appreciation of high standards of workmanship and the dignity of work; and to investigation and solution of technical and sociological problems related to various areas of manufacturing such as metalwork, plastics, and woodwork.

The student should be able to:

- Explore the relationship of industrial arts to the needs of individuals, industry, and society.
- Develop safety consciousness in the use of tools, machines, and processes, through a wide range of experiences related to the individual and to the production and servicing aspects of hobbies and industries in manufacturing.
- Gain information about the general occupational characteristics of a variety of career fields and match inter-

ests, abilities, likes, dislikes, and values to characteristics of various careers.

- Procure knowledge and skills related to imperial and SI metric systems of measurement and measuring devices and apply the knowledge and skills to measurement activities and problems pertinent to manufacturing.
- Obtain knowledge and skills related to the principles of planning and design and apply the knowledge and skills to plan, design, and construct manufactured projects and products.
- Explore the economic system and the economy in relation to manufacturing and consumer awareness.
- Acquire information about the nature, source, classification, processing, and properties of materials, and apply this information to manufactured projects and products.
- Obtain knowledge and skills related to separation processes and to the use, care, and maintenance of hand and power tools applicable to these processes for materials in manufacturing.
- Gain knowledge and skills related to forming and to the use, care, and maintenance of tools and equipment applicable to various forming processes for materials in manufacturing.
- Recognize the significance and gain understanding of the common methods of conditioning, and apply this understanding to various conditioning processes in manufacturing.
- Obtain knowledge and skills related to the methods, tools, equipment, and materials applicable to mechanical, adhesion, and cohesion fastening procedures in manufacturing.
- Acquire information and skills related to various finishing processes in manufacturing and perform these processes using tools and equipment with increasing accuracy.
- Recognize the significance of jigs and fixtures, gaining knowledge and skills related to designing, constructing, testing, and refining jigs and fixtures for use in manufacturing products from various materials.

- Gain an understanding of the principles and influence of mass production; explain the essential elements of industry; describe the basic steps in manufacturing product parts and in planning a manufacturing system of mass production; and apply the principles and procedures to mass production of products/projects.
- Develop an understanding of the enterprise sytem, the various business organizations and their importance to industrial production, the divisions of an industrial organization, the role of management in corporations, and the way corporations are established.

OBJECTIVES: COMMON MODULES FOR ALL AREAS OF STUDY

I. Student Orientation (C)

The student should be able to:

- define Industrial Arts;
- develop an understanding of the role of industrial arts;
- recognize the relationship between junior high school and senior high school industrial arts;
- develop understanding of the avocational and vocational activities and interests in industrial arts;
- list the subject clusters for junior high school industrial arts;
- identify the areas of study for each of the subject clusters.
- develop an awareness of the modules for each area of study;
- develop an awareness of the industrial arts program in the local school division/schools;
- identify reference materials;
- develop the ability to use reference materials;
- identify community resources.

II. Safety (C)

The student should be able to:

- understand the importance of safety;
- identify and follow behavior conducive to safety;
- identify and explain the symbols denoting hazards;
- accept responsibility for developing safety habits;
- explain the causes and effects of common industrial accidents;
- demonstrate a knowledge of the organization of the industrial arts laboratory;
- recognize the relationship of laboratory layout to safety;
- recognize the potential hazards inherent in tools, equipment, machines, and materials;
- explain the purpose of proper storage of tools, equipment, and materials;
- explain the importance of safe clothing;
- wear clothing appropriate for industrial arts laboratories;
- understand the importance of protective devices;
- use protective devices when required;
- describe daily procedures to be followed in industrial arts laboratories;
- identify and accept responsibility for housekeeping practices;
- identify emergency procedures;
- practice and use emergency procedures.

III. Careers (C)

The student should be able to:

- develop an awareness of the major groups of occupations;
- collect information about careers related to the major groups of occupations;
- identify careers related to the areas of study in the industrial arts program;
- develop an awareness of skills and aptitudes required for the major groups of occupations;
- identify skills required for specific jobs;
- identify personal interests, abilities, and needs;
- recognize the relationship of attitudes to working conditions;
- identify realistic educational and training plans for specific occupational areas;
- recognize the impact of technology on careers;
- explain the influence of social and economic trends on careers;
- identify the ways in which jobs are advertised;
- understand the purposes of a job description;
- explain the need for a resumé, an application, and an interview.

OBJECTIVES: METALWORK MODULES

I. Student Orientation (C)

II. Safety (C)

III. Careers (C)

IV. Measurement (C)

The student should be able to:

- define measurement;
- explain the need for measurement;
- recognize the need for standards;
- identify the basic types of quantity measurement;

- list and give application examples of SI metric and imperial units of measurement used in metalwork;
- identify common measuring tools;
- use common measuring tools;
- recognize the need for precision measuring instruments in metal work;
- identify precision measurement instruments;
- use precision measurement instruments.

V. Design and Construction (C)

The student should be able to:

- define planning;
- develop an understanding of the importance of planning;
- identify the components of planning;
- recognize the importance of design;
- identify the requirements for design;
- explain the relationship of design to strength, function, appearance, materials, cost, and quality;
- describe the basic elements of design;
- explain the principles of design;
- identify steps in the design process;
- develop an understanding of the importance of sketches, working drawings, and stretchouts/patterns;
- interpret sketches, working drawings, and stretchouts/patterns;
- prepare sketches, working drawings, and stretchouts/patterns;
- construct and evaluate products/projects.

VI. Consumerism (C)

The student should be able to:

- define economic system;
- explain the basic parts of economic systems;
- identify basic types of inputs;
- identify human needs;
- explain how metalwork meets human needs;
- recognize the relationship between metalwork and the economy;
- differentiate between needs and wants;
- recognize the concept of quality versus cost;
- explain the role of supply and demand;
- describe the effects of inflation;
- identify the positive and negative aspects of credit buying;
- explain the purpose and influence of advertising;
- recognize the relationship of sources of materials to the services and products of metalwork;
- explain the consequences following from consumption of metalwork products;
- justify the need for conservation and cost consideration of materials.

VII. Materials (C)

The student should be able to:

- develop an awareness of the nature and source of metals;
- define metals;
- identify geographical locations of metal ores;
- describe the development of mining- and metal-related industries in Manitoba;
- recognize the importance of metals;
- identify the classifications of metals;
- differentiate among the terms ferrous, nonferrous, base metals, alloys, and precious metals;
- classify metals;
- identify the basic steps in processing base metals;
- explain the basic steps in processing base metals;
- develop an understanding of the production of alloy metals;

- define standard stock;
- identify various shapes of common metal stock;
- explain the relationship of common shapes to sizes, measuring, and ordering of metal materials;
- explain the classification of metal properties;
- define the common properties of metals;
- identify methods of changing properties of metals;
- select metals according to properties for various products;
- combine other materials with metals.

VIII. Separation (C)

The student should be able to:

- define separating;
- identify methods of separating metals;
- describe the methods of separating metals;
- identify common hand tools for the separation process in metalwork;
- use hand tools applicable to separation processes;
- perform the separation proceses with hand tools with an increasing degree of accuracy;
- identify common power tools for the separation process;
- use power tools applicable to separation processes;
- perform the separation processes with power tools with an increasing degree of accuracy.

IX. Forming (C)

The student should be able to:

- define forming;
- identify methods of forming metals;
- define casting/molding;
- recognize the importance of the casting/molding process;
- identify and compare the main types of casting methods;
- cast/mold metals;
- define compressing and stretching;
- compare the principles influencing compressing and stretching procedures;
- describe various methods of compressing metals;
- form metals by compression;
- describe various methods of stretching metals;
- explain the drawing processes;
- explain the bending processes;
- form metals by stretching.

X. Conditioning (C)

The student should be able to:

- define conditioning;
- develop an understanding of the importance of conditioning;
- describe the internal structure of standard stock;
- identify common conditioning processes;
- develop an understanding of the relationship between conditioning and the properties of metals;
- explain the importance of thermal conditioning;
- identify thermal conditioning processes;
- condition metals by the thermal conditioning processes;
- explain the importance of mechanical deforming;
- identify the mechanical deforming processes;
- condition metals by using the mechanical deforming processes;
- explain the importance of chemical reactions;
- develop an understanding of the chemical reaction process in alloying;
- explain the importance of physical conditioning;
- condition metals by using a physical conditioning process.

XI. Fastening (C)

The student should be able to:

- define fastening;
- develop an understanding of the importance of fastening;
- identify methods of fastening;
- identify methods of mechanical fastening;
- describe the purpose of threaded fastening;
- recognize various types of threaded fasteners;
- use threaded fasteners;
- explain the purpose of non-threaded fastening;
- recognize the various types of non-threaded fasteners;
- use non-threaded fasteners;
- explain the purpose of seam fastening;
- recognize common types of sheet metal seams;
- join sheet metal with various types of seams;
- identify methods of adhesion fastening;
- define adhesive bonding;
- recognize the advantages and disadvantages of various types of adhesives;
- join metals by the adhesive bonding process;
- define soft soldering;
- recognize the importance of soft soldering;
- identify soldering conditions;
- describe the equipment, solders, and fluxes for the soldering process;
- fasten metal by the soldering process;
- define brazing;
- identify the equipment and supplies for brazing;
- use the brazing process to join metals;
- compare the brazing process with soft soldering and welding processes;
- define cohesion fastening;
- define welding;
- describe oxyacetylene, arc, and resistance welding processes;
- fasten metals with the welding process.

XII. Finishing (C)

The student should be able to:

- define finishing;
- develop an understanding of the importance of finishing;
- identify the categories of metal finishes;
- identify the various types of surface coatings;
- develop an understanding of the purpose of each type of surface coating;
- describe the characteristics of coating materials;
- recognize the significance of surface preparation;
- finish metalwork products by adding material to the surface;
- identify various methods of finishing by removing material from the surface;
- develop an understanding of the importance of each method of finishing by removing material from the surface;
- finish metal products by removing material from the surface;
- identify various mechanical treatment methods of finishing metal surfaces;
- develop an understanding of the importance of mechanical treatment methods for finishing metal surfaces;
- finish metalwork with mechanical treatment methods.

XIII. Jigs and Fixtures (C)

The student should be able to:

- define jig;
- define fixture;
- recognize the need for jigs and fixtures;
- identify types of jigs;

- explain the function of each type of jig;
- identify types of fixtures;
- explain the function of each type of fixture;
- develop an understanding of the principles of jig and fixture design;
- design jigs for metalwork products;
- build jigs for metalwork products;
- design fixtures for metalwork products;
- build fixtures for metalwork products;
- use jigs and fixtures to manufacture metalwork products.

XIV. Mass Production (C)

The student should be able to:

- develop an understanding of the manufacturing process of mass production;
- identify the principles of mass production;
- describe the influence of mass production;
- describe the essentials of industry;
- state the purpose of each element of industry;
- explain the basic steps followed by manufacturers of product parts;
- describe the basic steps requisite for planning a manufacturing system for mass production;
- produce products by applying the principles and procedures of mass production.

XV. Enterprise System (C)

The student should be able to:

- explain enterprise system;
- develop an understanding of the various systems of business organization;
- describe the advantages and disadvantages of each type of business organization;
- develop an understanding of the importance of organizing for industrial production;
- identify the five divisions of an industrial organization;
- explain the responsibilities of each of the five divisions of an industrial organization;
- develop an understanding of the relationship of divisions within an industrial organization;
- develop an understanding of the importance of a corporation;
- explain the procedures for incorporating a company;
- organize an in-school company to manufacture a product;
- explain how a corporation acquires capital;
- develop an understanding of the management process;
- define management;
- explain the components of the management cycle;
- describe the seven manufacturing M's;
- use the management functions.

OBJECTIVES: PLASTICS MODULES

I. Student Orientation (C)

II. Safety (C)

III. Careers (C)

IV. Measurement (C)

The student should be able to:

- define measurement;
- explain the importance of measurement;
- recognize the need for standards;
- identify the basic types of quantity measurement;
- list and give application examples of SI metric

and imperial units of measurement used in plastics;
- identify common measuring tools;
- use common measuring tools;
- recognize the need for precision measuring instruments in plastics;
- identify precision measurement instruments;
- use precision measurement instruments.

V. **Design and Construction** (C)

The student should be able to:

- define planning;
- develop an understanding of the importance of planning;
- identify the components of planning;
- recognize the importance of design;
- identify the requirements for design;
- explain the relationship of design to strength, function, appearance, materials, cost, and quality;
- describe the basic design elements;
- explain the principles of design;
- identify steps in the design process;
- develop an understanding of the importance of sketches, working drawings, and stretchouts/patterns;
- interpret sketches, working drawings, and stretchouts/patterns;
- prepare sketches, working drawings, and stretchouts/patterns;
- construct and evaluate products/projects.

VI. **Consumerism** (C)

The student should be able to:

- define economic system;
- explain the basic parts of economic systems;
- identify basic types of inputs;
- identify human needs;
- explain how plastics meet human needs;
- recognize the relationship between plastics and the economy;
- differentiate between needs and wants;
- recognize the concept of quality versus cost;
- explain the role of supply and demand;
- describe the effects of inflation;
- identify the positive and negative aspects of credit buying;
- explain the influence of advertising;
- recognize the relationship of sources of materials to services and products of plastics;
- explain the consequences pertinent to the consumption of plastics products;
- justify the need for conservation and cost consideration of materials.

VII. **Materials** (C)

The student should be able to:

- develop an awareness of the nature and sources of plastics;
- define plastics;
- describe the historical development of plastics materials;
- recognize the importance of plastics;
- identify the classifications of plastics according to physical properties;
- compare the two main groups of plastics classified by physical properties;
- classify plastics as thermoplastic or thermoset;
- identify classifications of plastics according to chemical sources;
- explain the basic process of making plastics material;

- define standard stock;
- identify the various forms of common plastics stock;
- explain the relationship of common forms to ordering plastics materials;
- explain the classifications of plastics properties;
- describe the various properties of plastics;
- perform comparative tests to determine various properties of plastics;
- identify recycled plastics products and their properties;
- select plastics for various products according to properties;
- combine other materials with plastics.

VIII. Separation (C)

The student should be able to:

- define separating;
- identify methods of separating plastics materials;
- describe the methods of separating plastics materials;
- identify common hand tools for separation processes in plastics materials;
- perform the separation processes with hand tools with an increasing degree of accuracy;
- identify common power tools for the separation processes for plastics materials;
- use power tools applicable to separation processes;
- perform the separation processes with power tools with an increasing degree of accuracy.

IX. Forming (C)

The student should be able to:

- define forming;
- identify common industrial methods for forming plastics materials;
- recognize the forming methods used in the industrial arts laboratory;
- explain the various forming methods used in the industrial arts labortory;
- identify the common plastics materials used in common laboratory processes;
- form plastics materials using various forming methods;
- identify causes and corrective methods for defective forming.

X. Fastening (C)

The student should be able to:

- define fastening;
- develop an understanding of the importance of fastening;
- identify the methods of fastening;
- identify methods of mechanical fastening;
- describe the purpose of add-on mechanical fasteners;
- recognize the various types of add-on/extrinsic fasteners;
- use add-on/extrinsic fasteners;
- recognize the various types of built-in/intrinsic fasteners;
- use built-in/intrinsic fasteners;
- identify methods of adhesion fastening;
- explain the relationship of adhesion fastening to plastics;
- compare thermoplastic and thermoset adhesives;
- identify the types of adhesive fastenings;
- join plastics materials by the adhesive bonding process;
- identify methods of cohesion fastening;

- develop an understanding of the importance of the various methods of cohesion fastening;
- describe the procedures for cohesive cementing;
- join plastics with cohesive cementing methods;
- recognize the various methods for heat sealing plastics;
- fasten plastics with heat sealing processes;
- define welding;
- describe the various plastics welding methods;
- fasten plastics with welding processes.

XI. Finishing (C)

The student should be able to:

- define finishing;
- develop an understanding of the importance of finishing;
- identify the categories of plastics finishes;
- identify the various types of surface coating;
- develop an understanding of the purpose of each type of surface coating;
- identify methods of adding materials to the surface of plastics;
- recognize the significance of surface preparation;
- finish plastics products by adding material to the surface;
- identify various methods of finishing by removing material from the surface;
- match the separating finishing methods to common plastics materials;
- finish plastics products by using separating methods;
- identify various mechanical methods of finishing surfaces of plastics products;
- finish plastics products with mechanical treatment methods;
- explain engraving, carving, and embedding;
- finish plastics products by engraving, carving, and embedding.

XII. Jigs and Fixtures (C)

The student should be able to:

- define jig;
- define fixture;
- recognize the need for jigs and fixtures;
- identify types of jigs;
- explain the function of each type of jig;
- identify types of fixtures;
- explain the function of each type of fixture;
- develop an understanding of the principles of jig and fixture design;
- design jigs for plastics products;
- build jigs for plastics products;
- design fixtures for plastics products;
- build fixtures for plastics products;
- use jigs and fixtures to manufacture plastics products.

XIII. Mass Production (C)

The student should be able to:

- develop an understanding of the manufacturing process of mass production;
- identify the principles of mass production;
- describe the influence of mass production;
- describe the essentials of industry;
- state the purpose of each element of industry;
- explain the basic steps followed by manufacturers of product parts;
- describe the basic steps requisite for planning a manufacturing system for mass production;
- produce products by applying the principles and procedures of mass production.

XIV. Enterprise System (C)

The student should be able to:

- . explain enterprise system;
- . develop an understanding of the various systems of business organization;
- . describe the advantages and disadvantages of each type of business organization;
- . develop an understanding of the importance of organizing for industrial production;
- . identify the five divisions of an industrial organization;
- . explain the responsibilities of each of the five divisions of an industrial organization;
- . develop an understanding of the relationship of divisions within an industrial organization;
- . develop an understanding of the importance of a corporation;
- . explain the procedures for incorporating a company;
- . organize an in-school company to manufacture a product;
- . explain how a corporation acquires capital;
- . develop an understanding of the management process;
- . define management;
- . explain the components of the mangement cycle;
- . describe the seven manufacturing M's;
- . use the management functions.

OBJECTIVES: WOODWORK MODULES

I. Student Orientation (C)

II. Safety (C)

III. Careers (C)

IV. Measurement (C)

The student should be able to:

- . define measurement;
- . explain the importance of measurement;
- . recognize the need for standards;
- . identify the basic types of quantity measurement;
- . give application examples of SI metric and imperial units of measurement used in woodwork;
- . identify common measuring tools;
- . use common measuring tools;
- . recognize the need for precision measuring instruments in woodwork;
- . identify precision measurement instruments;
- . use precision measurement instruments.

V. Design and Construction (C)

The student should be able to:

- . define planning;
- . develop an understanding of the importance of planning;
- . identify the components of planning;
- . recognize the importance of design;
- . identify the requirements for design;
- . explain the relationship of design to strength, function, appearance, materials, cost, and quality;
- . describe the basic elements of designing;
- . explain the principles of design;
- . identify steps in the design process;
- . develop an understanding of the importance of sketches, working drawings, and stretchouts/patterns;

- interpret sketches, working drawings, and stretchouts/patterns;
- prepare sketches, working drawings, and stretchouts/patterns;
- construct and evaluate products/projects.

VI. Consumerism (C)

The student should be able to:

- define economic system;
- explain the basic parts of economic systems;
- identify basic types of inputs;
- identify human needs;
- explain how woodwork meets human needs;
- recognize the relationship between woodwork and the economy;
- differentiate between needs and wants;
- recognize the concept of quality versus cost;
- explain the role of supply and demand;
- describe the effects of inflation;
- identify the positive and negative aspects of credit buying;
- explain the purpose and influence of advertising;
- recognize the relationship of sources of materials to the services and products of woodwork;
- explain the consequences pertinent to the consumption of woodwork products;
- justify the need for conservation and cost consideration of materials.

VII. Materials (C)

The student should be able to:

- develop an awareness of the nature and source of woods;
- define woods;
- identify geographical locations of forests;
- describe the development of forestry and forestry-related industries in Manitoba;
- recognize the importance of woods;
- describe the two major types of trees;
- compare softwood and hardwood;
- classify woods;
- identify the basic steps in processing trees and lumber;
- explain the basic steps in processing trees and lumber;
- develop an understanding of the production of plywoods;
- identify the types of composition woods;
- develop an understanding of the production of composition woods;
- identify the types of covering used on plywood and composition boards;
- define standard stock;
- identify the various shapes and sizes of common wood materials;
- explain the relationship of common shapes to sizes, measuring, and ordering of wood materials;
- explain the classifications of wood properties;
- explain the common properties of woods;
- select woods, according to properties, for various products;
- combine other materials with woods.

VIII. Separation (C)

The student should be able to:

- define separating;
- identify methods of separating woods;
- develop an understanding of the principles related to the separation processes;
- identify common hand tools for the separation processes in woodwork;

- use hand tools applicable to separation processes;
- perform separation with hand tools with an increasing degree of accuracy;
- identify common power tools for the separation processes in woodwork;
- use power tools applicable to separation processes;
- perform the separation processes with power tools with an increasing degree of accuracy.

IX. Forming (C)

The student should be able to:

- define forming;
- identify methods of forming wood;
- define bending;
- recognize the relationship of the condition and type of woods to the bending process;
- describe the techniques of using forms and clamps for bending wood;
- describe the Kerfing method of bending wood;
- bend wood materials;
- define laminating;
- recognize the importance of the laminating process;
- describe the laminating procedure;
- laminate a wood product.

X. Fastening (C)

The student should be able to:

- define fastening;
- develop an understanding of the importance of fastening;
- identify the methods of fastening;
- identify methods of mechanical fastening;
- describe the purpose of non-threaded fasteners;
- recognize the various types of non-threaded fasteners;
- use non-threaded fasteners;
- describe the purpose of threaded fastening;
- recognize the various types of threaded fasteners;
- use threaded fasteners;
- identify the various types of joints;
- join wood products with various types of joints;
- identify the types of hinges;
- install hinges;
- explain the purposes of adhesion fastening;
- identify the classifications of adhesives;
- join woods by the adhesion process.

XI. Finishing (C)

The student should be able to:

- define finishing;
- develop an understanding of the importance of finishing;
- identify categories of wood finishes;
- identify the various types of surface coatings;
- develop an understanding of the purpose of each type of surface coating;
- describe the characteristics of coating materials;
- recognize the significance of surface preparation;
- finish woodwork products by adding material to the surface;
- identify various methods of finishing by removing material from the surface;
- finish wood products by removing material from the surface;
- identify various mechanical treatment methods of finishing wood;
- finish wood with mechanical treatment methods.

XII. Jigs and Fixtures (C)

The student should be able to:

- define jig;
- define fixture;
- recognize the need for jigs and fixtures;
- identify types of jigs;
- explain the function of each type of jig;
- identify types of fixtures;
- explain the function of each type of fixture;
- develop an understanding of the principles of jig and fixture design;
- design jigs for woodwork products;
- build jigs for woodwork products;
- design fixtures for woodwork products;
- build fixtures for woodwork products;
- use jigs and fixtures to manufacture wood products.

XIII. Mass Production (C)

The student should be able to:

- develop an understanding of the manufacturing process of mass production;
- identify the principles of mass production;
- describe the influence of mass production;
- describe the essentials of industry;
- state the purpose of each element of industry;
- explain the basic steps followed by manufacturers of product parts;
- describe the basic steps requisite for planning a manufacturing system for mass production;
- produce products by applying the principles and procedures of mass production.

XIV. Enterprise System (C)

The student should be able to:

- explain enterprise system;
- develop an understanding of the various systems of business organization;
- describe the advantages and disadvantages of each type of business organization;
- develop an understanding of the importance of organizing for industrial production;
- identify the five divisions of an industrial organization;
- explain the responsibilities of each of the five divisions of an industrial organization;
- develop an understanding of the relationship of divisions within an industrial organization;
- develop an understanding of the importance of a corporation;
- explain the procedures for incorporating a company;
- organize an in-school company to manufacture a product;
- explain how a corporation acquires capital;
- develop an understanding of the management process;
- define management;
- explain the components of the management cycle;
- describe the seven manufacturing M's;
- use the management functions.

OBJECTIVES: MANUFACTURING MODULES

I. Student Orientation (C)

II. Safety (C)

III. Careers (C)

IV. Measurement (C)

The student should be able to:

- define measurement;
- explain the need for measurement;
- recognize the need for standards;
- identify the basic types of quantity measurement;
- list and give application examples of SI metric and imperial units of measurement used in manufacturing;
- identify common measuring tools;
- use common measuring tools;
- recognize the need for precision measuring instruments in manufacturing;
- identify precision measurement instruments;
- use precision measurement instruments;
- develop an understanding of computer-controlled measuring.

V. Design and Construction (C)

The student should be able to:

- define planning;
- develop an understanding of the importance of planning;
- identify the components of planning;
- recognize the importance of design;
- identify the requirements for design;
- explain the relationship of design to strength, function, appearance, materials, cost, and quality;
- describe the basic elements of designing;
- explain the principles of design;
- identify steps in the design process;
- develop an understanding of the importance of sketches, working drawings, and stretchouts/patterns;
- interpret sketches, working drawings, and stretchouts/patterns;
- prepare sketches, working drawings, and stretchouts/patterns;
- construct and evaluate products/projects.

VI. Consumerism (C)

The student should be able to:

- define economic system;
- explain the basic parts of economic systems;
- identify basic types of inputs;
- identify human needs;
- explain how manufacturing meets human needs;
- recognize the relationship between manufacturing and the economy;
- differentiate between needs and wants;
- recognize the concept of quality versus cost;
- explain the role of supply and demand;
- describe the effects of inflation;
- identify the positive and negative aspects of credit buying;
- explain the purpose and influence of advertising;
- recognize the relationship of sources of materials to the services and products of manufacturing;
- explain the consequences pertinent to the consumption of manufactured products;
- justify the need for conservation and cost consideration of materials.

VII. Materials (C)

The student should be able to:

- explain manufacturing;
- define materials
- develop an awareness of the nature and source of materials;

- define metals, plastics, and woods;
- recognize the importance of metals, plastics, and woods;
- explain the purposes of classification systems;
- compile a materials classification chart;
- define metals, non-metals, ferrous, non-ferrous, organics, and inorganics;
- classify materials;
- identify the basic steps in processing metals, plastics, and woods;
- explain the basic steps in processing metals, plastics, and woods;
- define standard stock;
- identify the various forms of common metal, plastics, and wood stock;
- explain the relationship of common forms to the ordering of metal, plastics, and wood materials;
- explain the classifications of metal, plastics, and wood properties;
- define the common properties of materials;
- select materials, according to properties, for various products;
- combine materials.

VIII. Separation (C)

The student should be able to:

- define separating;
- identify methods of separating materials;
- describe the methods of separating materials;
- identify common hand tools for separation of various materials;
- use hand tools applicable to separation processes;
- perform the separation processes with hand tools with an increasing degree of accuracy;
- identify common power tools for separation of various materials;
- use power tools applicable to separation processes;
- perform the separation processes with power tools with an increasing degree of accuracy.

IX. Forming (C)

The student should be able to:

- define forming;
- identify methods of forming;
- define casting/molding;
- recognize the importance of the casting/molding process;
- identify the basic steps used in all casting operations;
- explain various casting/molding methods;
- cast/mold various materials;
- define compressing and stretching;
- develop an understanding of the importance of compressing and stretching processes;
- identify the basic essentials of all compressing and stretching processes;
- explain the various compressing and stretching methods;
- form materials by compressing and stretching methods.

X. Conditioning (C)

The student should be able to:

- define conditioning;
- develop an understanding of the importance of conditioning;
- describe the internal structure of standard stock;
- explain the reasons why manufacturing industries condition materials;
- identify common conditioning processes;

- develop an understanding of the relationship between conditioning and the properties of materials;
- explain the importance of thermal conditioning;
- identify thermal conditioning processes;
- condition materials by using the thermal conditioning processes;
- explain the importance of mechanical deforming;
- identify the mechanical deforming processes;
- condition materials by using the mechanical deforming processes;
- explain the importance of chemical reactions;
- develop an understanding of chemical reaction process in alloying;
- explain the importance of physical conditioning;
- condition materials by using a physical conditioning process.

XI. Fastening (C)

The student should be able to:

- define fastening;
- develop an understanding of the importance of fastening;
- identify the methods of fastening;
- identify methods of mechanical fastening;
- describe the purposes of threaded fastening;
- recognize various types of threaded fasteners;
- use threaded fasteners;
- explain the purpose of non-threaded fastening;
- recognize the various types of non-threaded fasteners;
- use non-threaded fasteners;
- recognize common types of sheet metal seams;
- join sheet metal with various types of seams;
- identify the various types of joints for wood products;
- join wood products with various types of joints;
- identify the methods of adhesion fastening;
- join materials by the adhesive bonding process;
- fasten metal by the soft soldering process;
- identify methods of cohesion fastening;
- join materials with various cohesion fastening methods.

XII. Finishing (C)

The student should be able to:

- define finishing;
- develop an understanding of the importance of finishing;
- identify the categories of finishing for materials;
- identify the classifications of coating materials;
- describe the characteristics of various types of coating materials;
- identify separation/removing methods of finishing;
- list forming/shaping methods of finishing;
- prepare products for finishing;
- finish metals, plastics, and woods by using various types of finishing processes.

XIII. Jigs and Fixtures (C)

The student should be able to:

- define jig;
- define fixture;
- recognize the need for jigs and fixtures;
- identify types of jigs;
- explain the function of each type of jig;
- identify types of fixtures;
- explain the function of each type of fixture;
- develop an understanding of the principles of jig and fixture design;

- design jigs for products being manufactured;
- build jigs for products being manufactured;
- design fixtures for products being manufactured;
- build fixtures for products being manufactured;
- use jigs and fixtures to manufacture products.

XIV. Mass Production (C)

The student should be able to:

- develop an understanding of the manufacturing process of mass production;
- identify the principles of mass production;
- describe the influence of mass production;
- describe the essentials of industry;
- state the purpose of each element of industry;
- explain the basic steps followed by manufacturers of product parts;
- describe the basic steps requisite for planning a manufacturing system for mass production;
- produce products by applying the principles and procedures of mass production.

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XV. Enterprise System (C)

The student should be able to:

- explain enterprise system;
- develop an understanding of the various systems of business organization;
- describe the advantages and disadvantages of each type of business organization;
- develop an understanding of the importance of organizing for industrial production;
- identify the five divisions of an industrial organization;
- explain the responsibilities of each of the five divisions of an industrial organization;
- develop an understanding of the relationship of divisions within an industrial organization;
- develop an understanding of the importance of a corporation;
- explain the procedures for incorporating a company;
- organize an in-school company to manufacture a product;
- explain how a corporation acquires capital;
- develop an understanding of the management process;
- define managemennt;
- explain the components of the management cycle;
- describe the seven manufacturing M's;
- use the management functions.

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implementation

IMPLEMENTATION

PROGRAM DESIGN

The curriculum guides have been designed to help teachers meet the needs of adolescents, with relevance to the rapid changes in society. These guides are flexible in order to encourage teachers to use personal knowledge and creativity in planning and implementing programs for each of grades seven, eight, and nine. The program contains the following features:

1. The format of the previous industrial arts curriculum has been changed and the subject content is more comprehensive. The format contains subject clusters, areas of study for each subject cluster, and core and optional modules for each area of study.

2. Practical and theoretical knowledge are interrelated. The content is practical in its purpose, organization, and use, and theoretical in recognizing and understanding the concepts of self and interpersonal relationships, and the processes by which problems are solved and decisions are made.

3. Ideally, the curriculum is student-oriented in content and in approach to instruction. Emphasis is placed on creative exploration, self-direction, and independence. Because peer relationships are so important, some group work is emphasized. Instruction should be flexible to accommodate the wide variation in individual growth rates and stages of development.

4. The industrial arts curriculum has clearly defined objectives and program goals which become the criteria by which content is specified, procedures are developed, materials and resources are selected, and evaluative techniques are prepared.

5. Core modules with accompanying objectives have been identified for each area of study. For extended programs and maximum time allotment, teachers are expected to pursue topics beyond the core modules.

6. The sequential order within the subject clusters provides a systematic approach to the development of the program. The following are other approaches which will allow teachers flexibility in selecting learning content and processes to help students develop skills, attitudes, and understanding as bases for making and implementing reasonable, responsible decisions.

   The Process Approach involves the mastery of essential processes, such as searching, classifying, and categorizing information; hypothesizing, testing, valuing, criticizing, planning, problem-solving, and decision-making; and reporting.

   The Project Approach incorporates a number of different educational activities, such as investigating, analyzing, planning, constructing, synthesizing, evaluating, purposing, defining, and relating. The project should be a means to a goal and not the goal itself. The purposes of the project approach are to implement and develop the content and processes related to the area of study, as well as to contribute to the development of individuals.

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The Decision-Making Approach is basic to all areas of the program and includes the processes of inquiry, valuing, decision-making, and action.

The Needs Approach assumes that individuals and groups of individuals have certain physical, aesthetic, social, and psychological needs, and is based on meeting those needs.

The Problem Approach, the case study, is based on the observation that individuals, groups, communities, and businesses encounter problems which relate to survival and living in society. The techniques used in the classroom should include a variety of problem situations related to everyday living.

7. Because learning is unique for each student, in every aspect of industrial arts, a rich environment for exploration must be provided. The environment for learning should include attractive, well organized and safe surroundings, suitable and sufficient materials, and good working equipment.

   Learning is facilitated if student purposes are achieved and if the student participates in the selection and planning of classroom projects. Classroom experiences should progress from one successful accomplishment to another.

8. The suggested activities are designed to help students achieve objectives. These experiences help students acquire knowledge, learn skills, evaluate attitudes and values, and develop understanding, appreciation, and perception. The most relevant activities lead to the achievement of the objective and lend support and credibility to the topic.

   The activities are suggestions only and are intended to provide initial assistance in developing a wide range of activities to meet the students' needs. Students should be involved in the selection of learning experiences. Teachers must consider the cultural background of students, previous experience, and students with special needs to provide maximum opportunities for student learning.

   The structure of the content is the key to the encouragement of further learning.

SCOPE AND SEQUENCE

The subject clusters and areas of study taught will be dependent upon the type of laboratory and equipment. Some of the modules for the areas of study chosen may be taught separately as outlined, or combined. Industrial arts classes may be coeducational, all girls or all boys, or scheduled by class or areas of study selected.

Teachers should emphasize and integrate vocabulary study, safety, consumerism, career information, decision-making, interpersonal relationships, positive attitudes and work habits, communication skills, resource management, needs, values, goals, and laboratory organization throughout the program. To this end, these topics are woven into each area of study.

The scope and sequence should be a developmental progression of tasks and learning related to the areas of study and the modules chosen for each grade level. The following are criteria to consider when making choices:

1. the logical development of learning in each area;
2. the geographical and cultural background of the students;
3. students' maturation;
4. students' needs, including special needs, developmental tasks, experiences;
5. the amount of repetition that may be justified;
6. provision for new and exciting experiences;
7. the extent to which learning can be extended;
8. the resources available;
9. the most effective use of time, energy, and equipment.

TIME ALLOTMENT

Recommended time allotment for junior high industrial arts is 10% of the total program, 30 minutes daily/150 minutes weekly. One percent of time equals approximately 15 minutes of work per week. It is suggested that industrial arts be scheduled twice in the week or cycle. Different time blocks may have to be planned for students who have to travel to attend industrial arts classes. The time may also limit the number of objectives and/or projects which can be selected. It is recommended that the following flexible time allotments be used for the various grade levels:

. Grade 7 - 10-12%
. Grade 8 - 10-12%
. Grade 9 - 10-12%
. O.E.C. Grades 7, 8, 9 - 14-20%

There should be a balance of time alloted to the theoretic and practical aspects of the program. It is recommended that teaching theory comprise 30-40% of the time allotment and student practice comprise 60-70%. The estimated time listed for each module in the guide should be followed during instruction of theory and practice.

INTEGRATION

Within the industrial arts program, specific approaches and topics may be supportive of other programs in the school. Industrial arts students may share and integrate studies in such subjects as related mathematics, science, communication, and work adjustment (human relations) with mathematics, science, English, and guidance programs. In addition, units on energy and resource management, consummer education, career awareness, safety, and occupational aspects may be developed from topics included in the industrial arts curriculum.

Schools at the middle years level may develop a program for the pre-adolescent as an exploratory program prior to the implementation of industrial arts at the introductory level.

SELECTION OF MATERIALS

The suggested activities in the curriculum refer, in some instances, to approved textbooks and support materials which are basic to these activities. Classroom sets of selected, recommended materials would be desirable. There should be a balance of materials in and among all areas. Additional recommended references for each area of study are included in the bibliography.

The use of a variety of resource materials enriches the experiences of students in individual and group work. Because a wide variety of textbooks and publications are available in Manitoba schools, each teacher can support instruction with current information, suitable to student needs. Recently published textbooks and support materials are in metric. Industrial arts teachers have been introducing metric measurements and purchasing necessary equipment since Canada's conversion to the SI system.

EVALUATION

Evaluation is part of the education process and is necessary to determine whether the objectives have been met. It should assess various abilities, knowledge, and progress towards some objective(s). It should be considered as an ongoing, cooperative process of making judgments based on documented past and present experiences, with the aim of influencing the direction of future learning experiences.

The areas of study and modules emphasize both the practical aspects of skill mastery and the principles associated with the theories in industrial arts. Students should be involved in evaluating their progress, in determining objectives for the areas of study and the modules, and in selecting methods of evaluation.

PROCESS OF EVALUATION

The purposes of evaluation in a given situation vary according to the needs at the time:

- assessing the attainment of an objective;
- measuring various aspects of learning, such as knowledge, values, and manual skills;
- discovering what students already know;
- motivating students to learn;
- providing information for guidance and counselling;
- providing a basis for curriculum change.

Stating objectives is the first and most important step in the evaluation process. They can be stated in a variety of ways and can provide for cognitive, affective, and psychomotor outcomes at all levels, from simple to complex. The interrelationships among these three domains are evident. Seldom does a learning situation involve only one, and often there are situations which involve all three.

Cognitive objectives should include all six cognitive levels. Affective objectives should help students become aware of their own values and appreciate the need for tolerance of the values of others. Psychomotor objectives should stress the process of learning rather than the product.

Objectives are most effective in evaluation when they are:

- stated in terms of desired student learning outcomes;
- consistent with the structure of the subject matter;
- realistic in terms of students' abilities;
- related to learning principles;
- respective of the needs of the learners.

EVALUATION TECHNIQUES AND METHODS

The following points apply to all evaluation techniques and methods:

- The choice of evaluation procedure will reflect the purposes for which results will be used.
- The greater the variety of evaluation techniques used,

the more probable is a fair judgment.

- Motivation and achievement are affected by the type of evaluation method chosen.
- The intent of an objective and the method used to evaluate should be related.
- To be sound, the procedure selected must measure the content it is chosen to measure.
- The type of subject matter taught affects the choice of evaluation techniques.
- Attitudes are more likely to be positive if students participate in determining objectives, selecting means of evaluation, and evaluating their own progress.
- When learners can use self-evaluation techniques, they are better able to identify their own needs and to take initiative in learning.
- The effectiveness of evaluation techniques is affected by the balance among validity, reliability, usability, and the evaluation techniques selected.

Evaluation techniques may be classified as:

1. Real life situations:
    - observational techniques;
    - peer appraisal and self-report techniques.
2. Simulation techniques.
3. Laboratory management and techniques.
4. Projects. When ranking, quality is important but the time taken to complete the project must also be considered. The project should show evidence of an appreciation of the dignity of craftsmanship and a pride in the high level of achievement.
5. Tests. Tests provide some type of educational feedback that other techniques cannot provide. They include written tests, oral tests, performance tests, and written exercises.

STUDENTS WITH SPECIAL NEEDS

Both gifted students and those with special handicaps may benefit from study in the industrial arts program. Teaching these students successfully requires a sound knowledge of their characteristics and of effective ways of teaching them, and a desire to release the potential of these students for satisfying living.

Special needs may be categorized as:

- Physical--deafness/hearing impairment, blindness/visual impairment, orthopedic handicap, general health impairment.
- Cultural--language and experiential background effects.
- Emotional--ranging from mental illness (severe) to interpersonal relationship problems (less severe).
- Intellectual--general cognitive ability, with particular reference to conceptualization and abstraction.

Administrators and teachers have identified the following five areas of educational needs for special students (the degree of need varies according to the individual):

1. socialization skills;
2. positive self-concept development;
3. daily living activities experiences;
4. independence;
5. employability and occupational skill development.

STRATEGIES TO DEVELOP AN APPROPRIATE PROGRAM

- Be as well informed about students as possible.

- Be aware of impact of various family lifestyles.

- Apply teaching strategies and materials consonant with the students' learning strengths and weaknesses, and cognitive functioning abilities.

- Some teaching strategies are applicable for all learners, regardless of ability level; e.g., reinforcement and encouragement, simple clear directions, use of examples, and fostering a caring relationship.

- All students, regardless of handicap, need to learn to read, write, compute, make decisions and solve problems.

- Each student with a special need presents a unique challenge to the teacher to develop basic concepts and skills for that individual to proceed independently to the level of his/her ability.

- Some adaptation of the industrial arts facility and special equipment may be necessary for convenient and safe use of equipment and space. An enriched program may require additional materials and laboratory equipment.

- Essential content and skills are necessary for the handicapped student to master, as well as for everyone else.

- Instruction for the handicapped should be as systematic as possible.

- Content and/or skills should be broken down into small, discrete segments, then linked together in a logical, organized sequence. Sometimes, the teacher needs only to decrease the degree of content and/or increase the number of examples to aid the low-ability learner.

- Constant reinforcement is important. Retention problems are reduced if strategies include careful task analysis, hands-on experiences, tactile demonstrations, and recognition of individual differences and needs.

- Encourage the optimal development of the gifted students by enriching the program, employing unusual and challenging teaching and motivational devices, and encouraging students to maintain established high levels of achievement.

- All students should be encouraged to experiment, innovate, search, test, and observe.

- The instructional approach should stimulate students' range of knowledge, skills, and their desire for expanding creative abilities, and provide opportunities to work independently, assume responsibility, and develop leadership abilities.

common modules

COMMON MODULES: Student Orientation,
Safety, Careers

COMMON MODULES

I. STUDENT ORIENTATION (C.)

Estimated Time: 3 hours

MAJOR OBJECTIVE: To explore the relationship of industrial arts to the needs of individuals, industry, and society.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Integrate and emphasize this topic throughout all areas of study.	
A. PROGRAM OVERVIEW	Have students prepare and maintain a notebook as an ongoing project. Discuss the purpose of maintaining a well-organized notebook. Point out that the notebook will aid students to build upon ideas and information gained in class. Encourage students to include the following in the notebook project: notes, sketches, illustrations, diagrams, articles from newspapers and technical periodicals, hand-outs, and instruction sheets.	Notebook PURPOSE OF THE NOTEBOOK PROJECT 1. To provide a record of learning and progress 2. To develop a store of reference information
The student should be able to:		
1. define Industrial Arts;	Have students locate, discuss, and compare definitions for industrial arts. Ask them to formulate their own definition.	INDUSTRIAL ARTS: A phase of general education which serves to familiarize students with the tools, products,

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Emphasize the following during the discussion of definitions. Industrial arts is pertinent to a body of related subject matter or courses and is organized to develop understanding of technical, consumer, occupational, recreational, organizational, managerial, social, historical, cultural, and technological aspects of industry; it involves experimenting, designing, constructing, and evaluating, provides opportunities for creativity and problem solving, and aids individuals in making informed and meaningful occupational choices.	processes, and occupations of industry as well as with the social and economic phenomena of the technological world in which they live and work OR A curriculum area which includes phases of general education dealing with technology (its evolution, use, and significance), with industry (its organization, materials, occupations, processes, and products), and with the problems and benefits resulting from the technological and industrial nature of society
2. develop an understanding of the role of industrial arts;	Discuss the role of industrial arts in the general education of students. Relate the discussion to the definition of industrial arts and the program goals common to all levels of industrial arts.	Industrial Arts 7-9: Construction, Graphic Communications, Power/Energy, and Manufacturing, Manitoba Department of Education GOALS COMMON TO ALL LEVELS OF INDUSTRIAL ARTS 1. Development of an understanding of industry and its place in our culture 2. Discovery and development of individual talents, aptitudes, interests, and potentialities for technical pursuits and applied sciences

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
		3. Development of an understanding of industrial processes and the practical application of scientific principles 4. Development of basic skills in the proper use of common industrial tools, machines, and processes 5. Development of problem-solving and creative abilities involving materials, processes, and products of industry
3. recognize the relationship between junior high school and senior high school industrial arts;	Describe the relationship between junior high and secondary school programs for industrial arts. Have students refer to the goals common to all levels of industrial arts and collect information to prepare bulletin board displays, charts, or reports about both levels of programs.	Curriculum guides for senior high school programs in industrial arts
4. develop understanding of the avocational and vocational activities and interests in industrial arts.	Explain the terms avocation and vocation. Discuss the relationship and the difference between avocational and vocational activities pertinent to industrial arts. Emphasize that laboratory activities and projects develop knowledge and skills to attain both the avocational and vocational goals of industrial arts. Make students aware of the recreational aspects of industrial arts. Provide information and activities related to the basic processes of various types of industries so that students may be more competent in choosing	AVOCATION: An activity pursued in addition to one's regular work or profession, usually for enjoyment VOCATION: A regular occupation or profession, usually requiring special aptitude or qualification

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	vocation(s). Have students prepare collages, bulletin board displays, charts, posters, brochures, or reports about the avocational and vocational aspects of industrial arts.	
B. JUNIOR HIGH SCHOOL INDUSTRIAL ARTS The student should be able to:		
1. list the subject clusters for junior high school industrial arts;	Make students aware of the subject clusters in the industrial arts program for junior high schools in Manitoba. Provide information about each of the subject clusters.	SUBJECT CLUSTERS FOR INDUSTRIAL ARTS IN THE JUNIOR HIGH SCHOOL 1. Construction 2. Graphic Communications 3. Power/Energy 4. Manufacturing
2. identify the areas of study for each of the subject clusters;	Point out the areas of study pertinent to each of the subject clusters. Have students collect information and prepare diagrams, charts, and posters about the relationship between the areas of study and the subject clusters. Discuss purposes of studying the subject clusters and have students prepare illustrated reports/brochures. Have students identify and discuss some of the industrial processes and technological developments for each of the areas of study.	SUBJECT CLUSTERS — AREAS OF STUDY 1. Construction — Construction 2. Graphic Communications — Drafting Graphic Arts Graphic Communications 3. Power/Energy — Electricity/Electronics Power Mechanics Power/Energy

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
		SUBJECT CLUSTERS — AREAS OF STUDY 4. Manufacturing — Metalwork Plastics Woodwork Manufacturing
3. develop an awareness of the modules for each area of study;	Prepare transparencies, charts, posters, brochures, and/or handbooks to provide students with information about the various modules in each of the areas of study. Have students discuss the correlation of the modules to the areas of study and the subject clusters.	*Industrial Arts 7-9: Construction, Graphic Communications, Power/Energy, and Manufacturing*, Manitoba Department of Education
4. develop an awareness of the industrial arts program in the local school division/schools.	Discuss the industrial arts subject clusters and areas of study available in the school division and schools. Take students on a tour of the laboratories, and provide them with handouts describing the program.	Industrial arts laboratory/laboratories
C. RESOURCE MATERIALS	Integrate study of the proper use of reference materials throughout this program.	
The student should be able to:		
1. identify reference materials;	Prepare a display of reference materials related to industrial arts and explain their use (or ask the librarian to do the above).	REFERENCE MATERIALS 1. Catalogues

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
		2. Service manuals 3. Directories (city, telephone, trade) 4. Machine equipment and tool manuals 5. Textbooks 6. Periodicals 7. Audio-visual materials
2. develop the ability to use reference materials;	Provide students with opportunities to use reference materials for technical research, report writing, problem solving, and projects.	
3. identify community resources.	Have students assist with a compilation of lists of industries, speakers, and other community resources to enhance teaching/learning strategies for industrial arts.	Lists of industries, speakers, and other community resources

II. SAFETY (C.)

Estimated Time: 4 hours

MAJOR OBJECTIVE: To develop safety consciousness in the use of tools, machines and processes, through a wide range of experiences related to the individual and to the production and servicing aspects of hobbies and industries in metalwork, plastics, woodwork, and manufacturing.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Integrate safety instruction and practice throughout all areas of study in the industrial arts program. Provide a continuous safety program related to each area of study.	
A. SAFETY AWARENESS The student should be able to:		
1. understand the importance of safety;	Discuss the contribution of knowledge, skills, and positive attitudes to safe living and working conditions in homes, schools, and communities.	*On Guard* (colour filmstrip, cassette, program guide), Prentice-Hall *If I Had a Hammer* (16 mm colour film), Manitoba Department of Education
2. identify and follow behavior conducive to safety;	Discuss the importance of behaviour in relation to safe practices. Develop a set of rules for behaviour, making students aware of the reasons for and the advantages of each rule. Have students prepare posters, charts, or transparencies of the rules. Observe students, emphasizing that each has a responsibility not only for personal but for group safety.	*Tips For New Employees* (slides), available from Workplace Safety and Health Division, Department of Environment and Workplace Safety and Health, 1000 - 330 St. Mary Avenue, Winnipeg, MB R3C 3Z5

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
3. identify and explain the symbols denoting hazards;	Show students the various symbols denoting hazards: fire, explosion, poison, and others. Encourage students to study charts and posters about symbols for safety hazards.	The Safety Program (colour filmstrip, cassette, program guide), Prentice-Hall General Shop Safety (colour, sound filmstrip), AIM Educational Aids
4. accept responsibility for developing safety habits;	Make students aware that they are responsible for safety. Emphasize that safety in the home, classroom, industrial arts laboratory, school, and community means protecting oneself and others from possible injury and danger. Explain the ABC of safety: Always Be Careful! Remind students frequently about the need to be safety conscious by integrating safety instruction throughout the areas of study in the program.	Safety/Health Guide for Industrial Arts, Vocational Industrial, Home Economics, and Business Education, Manitoba Department of Education The Workplace Safety and Health Act, Manitoba Statutes, Queen's Printer Safety Attitudes (slides), available from Workplace Safety and Health Division, Department of Environment and Workplace Safety and Health, 1000 - 330 St. Mary Avenue, Winnipeg, MB R3C 3Z5
5. explain the causes and effects of common industrial accidents.	Discuss the relationship between causes and effects of accidents. Assign readings from reference materials, periodicals, and daily newspapers for class discussion on industrial accidents. Invite guests to speak on accidents and their prevention. Explain the relationship between safety requirements in the industrial arts laboratory and those in industry.	Everything to Lose, The Split Second, (16 mm colour films), available from the Workplace Safety and Health Division, Department of Environment and Workplace Safety and Health, 1000 - 330 St. Mary Avenue, Winnipeg, MB R3C 3Z5 Occupational Health and Safety: A Training Manual, Copp Clark Pitman It's Happened Before (16 mm colour film), Film Library, Manitoba Hydro

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
B. ORGANIZATION OF LABORATORY		
The student should be able to:		
1. demonstrate a knowledge of the organization of the industrial arts laboratory;	Take students on a tour of the industrial arts laboratory/laboratories and emphasize the relationship among safety, cleanliness, and organization. Encourage students to study safety charts, posters, and signs placed around the laboratory/laboratories. Have them locate fire extintguishers, first-aid kits, telephones, and fire exits.	Industrial arts laboratories Student work stations Safety charts, posters, signs Setting Up Shop Safety (Education Service), Workplace Safety and Health Division, Department of Environment and Workplace Safety and Health, 1000 - 330 St. Mary Avenue, Winnipeg, MB R3C 3Z5
2. recognize the relationship of laboratory layout to safety;	Point out that the laboratories provide an environment for the development of safety concepts and habits that can help guide the actions of the individual in all life situations. Assess the layout of each laboratory with the students. Have students list the limitations and unsafe conditions in the layout of each laboratory and suggest how to overcome or cope with these. Emphasize the importance of orderliness and safety in each laboratory. Point out areas where accidents may happen.	Confined Space Hazards (16 mm colour film), available from the Workplace Safety and Health Division, Department Environment and Workplace Safety and Health, 1000 - 330 St. Mary Avenue, Winnipeg, MB R3C 3Z5

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
3. recognize the potential hazards in-inherent in tools, equipment, machines, and materials;	Show students the difference between the incorrect and correct use of tools, equipment, machines, and materials. Have students practice correct usage and handling techniques. Make students aware of how accidents can occur and how they can be avoided.	Using Hand and Bench Tools, Operating Power Machines (colour filmstrips, cassettes, program guide), Prentice-Hall
4. explain the purpose of proper storage of tools, equipment, and materials.	Identify and discuss the storage areas requisite for various types of tools, equipment, and materials. Point out why proper storage areas are essential for safety in each laboratory.	
C. CLOTHING AND PROTECTIVE DEVICES The student should be able to:		
1. explain the importance of safe clothing;	Make students aware of the relationship of clothing to safe work practices. Have students, individually or in groups, prepare displays, charts, and posters about safe clothing for each area of study.	Bulletin board displays, charts, posters
2. wear clothing appropriate for industrial arts laboratories;	Have students determine the kind of clothing best suited to each industrial arts laboratory. Point out the hazards associated with loose clothing, neckties, jewellery, long hair, and long sleeves. Have students demonstrate methods of overcoming these hazards.	Your Feet Are Your Fortune (slides), available from the Workplace Safety and Health Division, Department of Environment and Workplace Safety and Health, 1000 - 330 St. Mary Avenue, Winnipeg, MB R3C 3Z5

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
3. understand the importance of protective devices;	Identify and explain the purpose of various protective devices. Demonstrate the methods of sanitizing protective devices, such as safety glasses, protective hearing devices, and respirators.	PROTECTIVE DEVICES 1. Gloves 2. Safety glasses 3. Respirators 4. Hard hats 5. Hearing devices (ear plug, ear muff) 6. Footwear 7. Safety straps 8. Hair bands/nets 9. Machine guards 10. Aprons
4. use protective devices when required.	Demonstrate the proper use of protective devices. Insist that students use protective devices when needed. Use posters, transparencies, slides, photographs, and films to show the correct use of protective devices. Keep safety posters near machines and equipment.	Protecting Your Eyes (colour filmstrip, cassette, program guide), Prentice-Hall The Sound of Sounds, We'll See Tomorrow (16 mm colour films), and Guard Your Sight (slides), available from the Workplace Safety and Health Division, Department of Environment and Workplace Safety and Health, 1000 - 330 St. Mary Avenue, Winnipeg, MB R3C 3Z5
D. PROCEDURES The student should be able to:		
1. describe daily procedures to be followed in industrial arts labortories;	Identify and discuss the daily procedures for industrial arts laboratories. Have students list and follow daily procedures. Make them aware of the relationship of well organized daily procedures to safety.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
2. identify and accept responsibility for housekeeping practices;	Point out that good housekeeping practices will aid in preventing accidents as well as in providing a pleasant, well-organized environment for work and learning. Have students accept responsibility for the following daily housekeeping activities (if applicable): . daily removal of all waste materials; . maintenance of safety zones, keeping aisle space and space around machines clear; . clean-up of shop equipment and floors at the end of each period; . reporting of unsafe tools, equipment, and machines.	Housekeeping Means Safekeeping (16 mm colour film), and Keep It Clean for Safety's Sake (slides), available from the Workplace Safety and Health Division, Department of Environment and Workplace Safety and Health, 1000 - 330 St. Mary Avenue, Winnipeg, MB R3C 3Z5
3. identify emergency procedures;	Make students aware of emergency procedures related to fire, first-aid, and accidents.	The A, B, C's and D's of Portable Fire Extinguishers (16 mm colour film), Film Library, Manitoba Hydro
4. practice and use emergency procedures.	Review and practice emergency procedures for leaving the laboratory. Discuss location and use of emergency equipment such as fire extinguishers and panic buttons. Explain the importance of an easily accessible, properly maintained and marked first-aid kit. Emphasize that only emergency first aid should be administered to serious injuries, since qualified medical personnel should prescribe treatment.	Preparing for Emergencies, Wounds, Sprains, Fractures, Shock, Fainting, Burns, Artificial Respiration (colour filmstrips, cassettes, program guide), Prentice-Hall

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Establish a procedure for reporting all accidents, no matter how trivial. Explain the purpose and the use of accident report forms. Have students complete accident report forms. Make them aware of the benefits available under the Workers' Compensation Act.	Examples of accident report forms The Workers' Compensation Act, Manitoba Statutes, Queen's Printer

III. CAREERS (C.) Estimated Time: 3 hours

MAJOR OBJECTIVE: To gain information about the general occupational characteristics of a variety of career fields and to match interests, abilities, likes, dislikes, and values to characteristics of various careers.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Integrate career instruction throughout all areas of study in the industrial arts program. Provide specific career information for each area of study.	
A. CAREER CLASSIFICATIONS The student should be able to:		
1. develop an awareness of the major groups of occupations;	Outline the major occupational groups. Discuss important points to consider in studying occupations. Use assignment sheets based on The Canadian Classification and Dictionary of Occupations.	The Canadian Classification and Dictionary of Occupations, Department of Manpower and Immigration, Canada
2. collect information about careers related to the major groups of occupations;	Encourage students to begin preparing well-organized and indexed career folders to study various careers intensively.	Training Manual for Canadian Classification and Dictionary of Occupations, Volume I, Department of Manpower and Immigration, Canada
	Point out the relationship between careers in major groups of occupations and the eleven areas of study in the industrial arts program.	Industrial Arts 7-9: Construction, Graphic Communications, Power/Energy, and Manufacturing, Manitoba Department of Education

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
3. identify careers related to the areas of study in the industrial arts program.	Have students prepare charts and posters for the classroom or reports for their career folders showing the relationship between possible career choices and the areas of study. Organize the instructional program so that the concepts studied in each specific area identify clearly the kinds of jobs involved. Develop and implement a career information centre or corner in the laboratory. Have students assist with the organization and sponsorship of a career fair in the laboratory, school, or community. Require students to select three possible occupations and show the training requirements for each.	Aircraft Mechanic, Architectural Drafting, Career of an Auto Mechanic, A Career in Cabinet Making, Careers in Graphic Arts: Silkscreening, The Electrician Kit, The Machinist in the Plastics Moulding Industry, Sheet Metal Working Is . . . (kits), available from Department of Education Library, 1181 Portage Avenue, Winnipeg, MB R3G 0T3
B. SKILLS AND APTITUDES The student should be able to:		
1. develop an awareness of skills and aptitudes required for the major groups of occupations;	Review the many careers pertinent to the major groups of ocupations in Canada, and have students locate similar information for the major groups of occupations in Manitoba. Ask them to prepare lists/maps of local industries/businesses and to identify the major occupations related to these. Have students develop a classroom	The Canadian Classification and Dictionary of Occupations, Department of Manpower and Immigration, Canada Canada Year Book and Canada Handbook, Statistics Canada

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	file of occupations found in the local business community. Discuss the relationship of industrial arts to various occupations and the skills and aptitudes required for these major groups of occupations.	Careers Manitoba, Volumes 1, 2, 3, 4, Employment and Immigration, Canada The Manitoba Career Guide, Manitoba Department of Education Manitoba Trade Directory, Sanford Evans Publishing Telephone and city directories Newspapers
2. identify skills required for specific jobs;	Provide students with information on job descriptions and titles that illustrate the variety of work in various types of industries. Have students research job descriptions for specific jobs of their choice. Have them identify the skills requisite for the jobs they choose.	The Canadian Classification and Dictionary of Occupations, Department of Manpower and Immigration, Canada
	Provide students with a list of educational and training programs related to major occupational areas and specific jobs. Have them prepare charts, posters, or reports on the educational requirements for the job(s) they investigate.	Textbooks for each of the areas of study in industrial arts.
3. identify personal interests, abilities, and needs;	Have students analyze personal interests and abilities by completing a self-assessment inventory at the beginning of the first year and at the end of the final year in the industrial arts program. Have them	Self-assessment inventory forms

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Include the following in the self-assessment inventory: interests, skills, likes, dislikes, goals, etc. Point out that each individual wishes to fulfill certain needs, hopes, and goals in a job. Have students identify and rank the ten most common needs and hopes related to a job. Encourage them to discuss the merits of the choices and the ranking of the needs and hopes.	
	Emphasize that in order to make up-to-date decisions about future careers, complete information about personal abilities, interests, hopes, and achievements, as well as current information about many jobs, should be compiled.	Careers, Reed Career Service (bimonthly) Current job information
	Have students compare personal information with statistics and data about jobs. Indicate that this process will help them to make appropriate career decisions. Point out that self-evaluation of interests and abilities provides the foundation for personal career planning.	
4. recognize the relationship of attitudes to working conditions;	Have students identify the attitudes that help people achieve on the job. Point out that regardless of future employment, students will be expected to work with others in a variety of situations. Explain the importance of good manners, cheerfulness,	INDICATORS OF A GOOD ATTITUDE 1. Punctuality 2. Attendance 3. Neatness 4. Honesty

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	and punctuality. Emphasize the importance of pride in work, self-confidence, safety consciousness, regular attendance, cooperation, industriousness, and friendliness. Have students prepare charts, posters, or reports on indicators of good attitudes. Use case problems, in-class decision-making exercises, and out-of-class group projects in the development of human relation skills.	5. Cooperation 6. Friendliness 7. Industriousness 8. Self-confidence
5. identify realistic educational and training plans for specific occupational areas;	Review skills required for specific jobs, the importance of personal interests, abilities, and needs, and the comparison of personal information with reference information. Have students match personal credentials with educational and vocational opportunities and requirements by completing an occupational analysis form. Relate the occupational analysis to the areas of study in the industrial arts program. Point out that the completion of an occupational analysis form for each job studied will provide important clues about future vocational goals and assist in the selection of a high school program of studies.	Creating a Career, Canadian Government Publishing Centre Occupational analysis forms Caprentry (B-2), Chemical and Plastics Processing (F-1), Concrete Finishing (B-3), Drafting (O-4), Electrical and Electronic Engineering (A-8), Electrical Power, Lighting and Wire Communications (B-4), Electronic Products Manufacturing (G-6), General Manufacturing (G-8), Graphic Arts (O-6), Insulating and Roofing Occupations (B-6), Mechanics (O-9), Metal Machining (G-11), Metal Products (F-4), Metal Shaping and Forming (G-12), Photography (D-5), Photographic Processing (O-13),

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
		Plastering, Painting and Paper Hanging (B-8), Printing (O-14), Rubber and Plastic Products Manufacturing (G-14), Sheet Metalwork (G-15), Wood Processing (F-9), Wood Products Manufacturing (G-19) (videorecordings: Career Awareness Resource Library), Library, Department of Education
6. recognize the impact of technology on careers;	Discuss the influence of technology on employment trends, life styles, and speed of change. Point out the changes in jobs and roles of employees. Make students aware of the relationship between technological developments and career preparation. Have students assess the extent to which technological change may downgrade or upgrade a given occupation by affecting the employment opportunities and occupational requirements.	The Thinking ?? Machine, Incredible Machine (films), Manitoba Telephone System, Public Relations Department Humanized Technology (video recording and viewer's guide), Fast Forward Series 1, Library, Manitoba Department of Education Implications (video recordings and viewer's guide), Fast Forward Series 2, Library, Manitoba Department of Education
7. explain the influence of social and economic trends on careers.	Identify and discuss social and economic trends and their effects on social and economic aspects of various occupations. Ask students to assess the future social and economic status of a given occupation and to identify alternative occupations requiring similar training and experience. Point out that alternative employment	Newspapers Radio and television news

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	should always be considered in the event that technological change eliminates a given occupation.	
C. JOB-SEARCH TECHNIQUES The student should be able to:		
1. identify the ways in which jobs are advertised;	Discuss methods used to advertise jobs. Have students collect and discuss job advertisements and prepare posters or displays of these.	JOB ADVERTISEMENT SOURCES 1. School guidance counsellors 2. Canada Manpower 3. Employment agencies 4. Newspapers, periodicals
2. understand the purposes of a job description;	Have students examine and assess the advantages and disadvantages of job descriptions. Ask them to discuss and list the purposes of job descriptions.	PURPOSES OF JOB DESCRIPTIONS 1. Outline duties 2. Describe routines 3. Assign responsibility 4. Delegate authority 5. Designate accountability 6. Prevent conflicts 7. Describe general ability requirements 8. Categorize personnel 9. List expected skills and attitudes 10. State desired education

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
3. explain the need for a resumé, an application, and an interview.	Have students collect examples of resumés, letters of application, and application forms. Have them explain the purposes and compare the format and the content of resumés, letters of application, and application forms. Point out that application forms and resumés often contain similar information. Ask students to write a resumé and a letter of application and to complete an application form for a specific job description or advertisement. Discuss interview processes and techniques. Emphasize that students will be expected to communicate in all career situations. Make students aware that good communication starts with an application and interview and continues with company/business reports and interaction with customers and co-workers. Point out the importance of basic reading, writing, speaking, and computing skills, and assist students to develop these in all class activities.	Resumés Letters of application Application forms

metalwork

CORE MODULES: Student Orientation, Safety, Careers, Measurement, Design and Construction, Consumerism, Materials, Separation, Forming, Conditioning, Fastening, Finishing, Jigs and Fixtures, Mass Production, Enterprise System

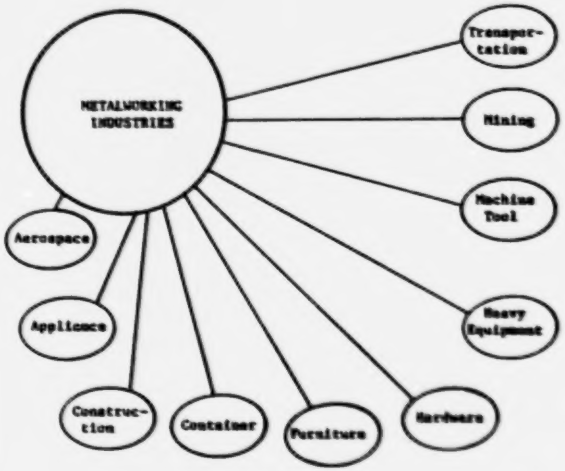
METALWORK

I. STUDENT ORIENTATION (C.)

Estimated Time: 3 hours

MAJOR OBJECTIVE: To explore the relationship of industrial arts to the needs of individuals, industry, and society.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	NOTE: Refer to Common Modules for Module I, Student Orientation. Emphasize the relationship of metals and metalwork to some of the basic needs in life, such as food, clothing, shelter, transportation, communication, and recreation. Point out that the modules in Metalwork explain basic theory and, through projects, provide students with opportunities to apply basic skills and principles and to acquire appreciation and knowledge of methods used in industry. Involve students in "brainstorming" sessions to define the four major kinds of metal production and to determine their uses.	Industrial Arts 7-9: Manufacturing (Metalwork, Plastics, Woodwork, Manufacturing), Module I, Student Orientation MAJOR METHODS OF METAL PRODUCTION 1. Casting--heating metal until it melts, then pouring it into a mold or form to harden 2. Hot working--heating metal until it becomes flexible, then bending, shaping, and forming it 3. Cold working--cutting, shearing, bending, and shaping metal without heating it 4. Machining--shaping metal by these machine processes: filing, drilling, turning on a lathe, grinding, planning, shaping, and milling

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	 METALWORKING INDUSTRIES Transportation Mining Machine Tool Heavy Equipment Hardware Furniture Container Construction Appliance Aerospace Point out that these industries may be added to the chart: agriculture, electronics, packaging, and recreation. Ask students to prepare illustrated charts related to various facets of the diagram above, and to add to the diagram.	

II. SAFETY (C.)

Estimated Time: 4 hours

MAJOR OBJECTIVE: To develop safety consciousness in the use of tools, machines, and processes, through a wide range of experiences related to the individual and to the production and servicing aspects of hobbies and industries in metalwork.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	NOTE: Refer to Common Modules for Module II, Safety. Emphasize the following: a) Students studying the basics of metalwork must learn safety precautions. b) The right way of doing a job is the safe way. c) The use of safety precautions is protection against injury. d) Safety is a matter of commmon sense and good judgment. e) The application of safety precautions in all laboratory activities is essential to making them a part of regular work habits. Have students discuss, observe, and prepare posters for six major safety rules pertinent to metalwork.	Industrial Arts 7-9: Manufacturing (Metalwork, Plastics, Woodwork, Manufacturing), Module II, Safety Metalwork, SI Metric ed., Chas. A. Bennett, Unit 4 Basic Metalwork, Chas. A. Bennett, Unit 3 Exploring Industrial Arts, McGraw-Hill Ryerson, pp. 7-10 Exploring Metalworking Basic Fundamentals, Goodheart-Willcox, Unit 4 MAJOR SAFETY RULES 1. Always dress correctly for the job 2. Follow directions 3. Practice good shop housekeeping 4. Learn to use tools and machines correctly 5. Avoid " clowning" 6. Report EVERY accident

III. CAREERS (C.)

Estimated Time: 3 hours

MAJOR OBJECTIVE: To gain information about the general occupational characteristics of a variety of career fields and to match interests, abilities, likes, dislikes, and values to characteristics of various careers.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	NOTE: Refer to Common Modules for Module III, Careers.	Industrial Arts 7-9: Manufacturing (Metalwork, Plastics, Woodwork, Manufacturing), Module III, Careers CAREERS C - Concern, Cooperation, Choices, Competence A - Appearance, Attendance, Attitude R - Reading, 'Riting, 'Rithmetic, References E - Experience, Equality, Example E - Effective use of time R - Respect, Recognition S - Spirit
	Integrate career instruction throughout this area of study by familiarizing students with many careers, thereby providing a basis on which to make career choices, and by encouraging self-evaluation in relation to career opportunities and future goals. Point out that a knowledge of career opportunities in metalwork will aid students in determining future educational, vocational, and lifeskill endeavours.	Metalwork, SI Metric ed., Chas. A. Bennett, Unit 2 Basic Metalwork, Chas. A. Bennett, Unit 1 Exploring Metalworking Basic Fundamentals, Goodheart-Willcox, Unit 18 Modern Metalwork, Goodheart-Willcox, Unit A-1

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Create an awareness of occupational families related to metalwork.	
	Prepare students for study in advanced vocational and technical programs in metalwork by providing them with occupational information and exploratory experiences directly related to current practices in industry and by acquainting them with programs available in secondary schools, community colleges, and universities.	Metal Workers (16 mm colour film), Library, Manitoba Department of Education Career Awareness Resource Library (videorecordings), Library, Manitoba Department of Education
	Acquire various display materials for the laboratory or classroom providing information about occupations and jobs related to metalworking.	Sheet Metal Working Is . . . (kit), Library, Manitoba Department of Education
	Implement a procedure encouraging students to prepare files of personalized occupational information, including data on personal interests, aptitudes, and achievements.	
	Emphasize the importance of being well informed about all aspects of a career, from educational requirements and employment opportunities to work duties and conditions.	
	Make students aware that career decisions are influenced not only by an individual's interests and work values, but also by his or her attitude toward change, risk taking, and helping others.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Involve students in research activities to develop their awareness of metalwork careers. Point out that many communities employ people in these job categories: a) Semi-skilled workers, helping skilled workers, operate production machinery and equipment, assemble manufactured parts into a final product, and inspect and test manufactured items to determine whether they operate satisfactorily. b) Skilled workers, having completed apprenticeship programs, perform exacting skills, such as working in the manufacture of musical instruments, ships and automobiles, or with sheet metal and steel. c) Technicians, assisting engineers, test various experimental devices and machines, help compile statistics, cost estimates, and technical reports, program parts for production by numerically and robotically controlled machines, and repair and maintain these machines. d) Supervisors, dealing with production problems and personnel, are responsible for meeting production schedules, maintaining material inventories, checking and supervising machine operations, and meeting shipping schedules.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	e) Professional people, in teaching and engineering, are employed at various levels. Have students enhance their knowledge of metalwork careers by taking part in individual and group projects like these: . preparing lists, charts, and bulletin board displays of occupations made possible directly or indirectly by metalworking industries; . researching and listing various metalwork industries in the local community and in the province, classifying them according to the metalwork they perform, and identifying the metalwork occupations represented; . preparing an illustrated report about a metalwork industry, following an outline similar to this: history, products made, rate of growth, number of people employed, kinds of occupations and their educational and skill requirements, employee salaries and benefits; . viewing films and preparing displays about the influence of computer technology and robotics on metalworking occupations; . visiting open house day at a regional comprehensive secondary school.	

IV. MEASUREMENT (C.)

Estimated Time: 4 hours

MAJOR OBJECTIVE: To procure knowledge and skills related to imperial and SI metric systems of measurement and measuring devices and to apply the knowledge and skills to measurement activities and problems pertinent to metalwork.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Integrate instruction, practice, and applications of measurement throughout each module in this area of study. Point out the need to follow safety precautions and procedures and to make accurate measurements.	
A. INTRODUCTION TO MEASUREMENT The student should be able to:		
1. define measurement;	Have students discuss and define measurement. Have them include this definition, along with others made in this area of study, in their notebooks. Emphasize that measurement is a method used to communicate information about size, shape, distance, and weight, and have students give examples of metalwork measurements related to these. Make students aware that measurement is made by comparing an unknown with a standard or known quantity.	MEASUREMENT: A method of communicating size, shape, distance, and weight

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
2. explain the need for measurement;	Make students aware of the relationship between good workmanship and accurate measurements. Have them identify ways in which measurement applies to various aspects of metalwork.	
3. recognize the need for standards;	Explain that standards for measuring in metalwork, developed over the years, have been agreed upon by organizations such as ISO, ANSI, and CSA, with representation from many industries. Indicate that these standards, the same throughout the world, aid in communicating information pertinent to metalwork measurements. Inform students that published standards define measurement of length, volume, area, weight, time, temperature, and other values.	ISO: International Organization for Standardization ANSI: American National Standards Institute CSA: Canadian Standards Association Standard Measurement (colour 16 mm film), Library, Manitoba Department of Education
4. identify the basic types of quantity measurement;	Identify and discuss the basic kinds of quantity measurement. Have students prepare charts, posters, displays, and/or reports about the basic types of quantity measurement.	BASIC TYPES OF QUANTITY MEASUREMENT 1. Length 2. Mass 3. Time 4. Temperature 5. Electric current 6. Amount of a substance 7. Light intensity Metric System Metric Units (colour transparency series, overlays, instructor's guide), AIM Educational Aids

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
5. list and give application examples of SI metric and imperial units of measurement used in metalwork.	Have students identify SI metric and imperial units of measurement used in various metalwork activities. Have students prepare charts for their notebooks or for the classroom identifying SI metric and imperial units of measurement and their applications in the metalwork industry. Emphasize the following:	Metalwork, SI metric ed., Chas. A. Bennett, Unit 3 Metalworking, McKnight Publishing, Chapter 3 Basic Metalwork, Chas. A. Bennett, Unit 28 Metric Measurement I: Measurement and Why We Need a Standard Measurement, Metric Measurement II: What Is the Metric System and How It Is Used (16 mm colour films), Library, Manitoba Department of Education

UNITS OF MEASURE

QUANTITIES	SI METRIC UNITS	IMPERIAL UNITS	APPLICATIONS
Length, distance	metre	yard foot, inch	Linear measurements Thickness, width, and length of metal materials
	millimetre	foot, inch	Length and width of metal products and buildings Layout work and measurements in respect to constructing parts of metal products
Area	square millimetre, square centimetre, square metre	square inch, square foot, square yard	Area of parts of metal products and metal buildings
Volume	cubic millimetre, cubic centimetre, cubic metre	cubic inch, cubic foot, cubic yard	Volumes of various types of metal stock
Mass/ Weight	kilogram	pound	Quantity unit of metal stock
Temperature	degrees Celsius	degrees Fahrenheit	Heat treating of metals
Pressure	KPa MPa	p.s.i.	Pressure and stress related to metals

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
B. MEASURING DEVICES The student should be able to:		
1. identify common measuring tools;	Acquaint students with common measuring tools. Point out that tools measure and mark metal stock. Have students learn to identify the tools by preparing labelled charts, posters, or displays of them.	COMMON MEASURING TOOLS 1. Rules 2. Flexible tapes 3. Dividers 4. Scribers 5. Squares 6. Wire and steel gauges 7. Temperature and pressure gauges
2. use common measuring tools;	Demonstrate working with common measuring tools, and allow students to explore their use.	
	Emphasize safety and discuss the relation between correct use and maintenance of tools to resultant products and projects.	Metalwork, SI metric ed., Chas. A. Bennett, Units 3, 7, 9 Basic Metalwork, Chas. A. Bennett, Units 4, 28
	Demonstrate procedures for measuring thickness, length, and width of sheet stock and heavy bar stock and assign similar activities to students.	Metalworking, McKnight Publishing, Chapter 3 Measuring and Marking Tools (filmstrip and cassette), School Services of Canada

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
		Sheet Metal Hand Tools (transparencies, overlays, instructor's guide), AIM Educational Aids
3. recognize the need for precision measuring instruments in metalwork;	Point out that accurate measurement is essential to safe mass production of interchangeable plastic parts by discussing the following: a) Every part must be accurately made to the size and shape specified. b) Parts made inaccurately do not fit other parts of the product. c) Inaccurate measurement can result in malfunctioning or premature breakdown. d) Parts manufactured in one product location are often fitted to a final product assembled in another location. e) The safety of individuals can depend on accurate measurements in the manufacture of such items as bicycles, motorcycles, automobiles, tractors, combines, airplanes, and space vehicles. Emphasize that precision measurement is part of life today. Ask students to illustrate this concept by way of posters, displays, reports, and demonstrations.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
4. identify precision measurement instruments;	Show precision measurement instruments (illustrated or actual). Have students prepare labelled charts or displays of these instruments. Discuss the influence of technology on precision measurement (e.g., the electronic micrometer). Have students use different sizes of cardboard mailing tubes to make a large working model of the hub and thimble of a micrometer.	PRECISION MEASUREMENT INSTRUMENTS 1. Calipers 2. Micrometers The Metric Vernier Caliper, The Vernier Caliper, The English Micrometer, The Metric Micrometer (colour filmstrips, cassettes, test materials, teachers' guide), Career Aids
5. use precision measurement instruments.	Demonstrate and then have students use the correct procedures for measuring with precision instruments available in the laboratory. Explain that these instruments must be well maintained if they are to function accurately. Provide students with diagrams of various micrometer settings and ask them to record readings. Prepare a transparency, complete with several overlays, to be used in teaching beginning students to read a micrometer or other precision measurement instruments. Ask students to prepare a research paper on how temperature changes affect measuring accuracy. Have students carry out these procedures with one-inch long pieces of	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	aluminum, brass, steel, plastic, and cast iron: a) Record the exact length of the various metal pieces at room temperature with a micrometer. b) Place the metal pieces in a freezer for twenty-four hours, quickly measuring them to record findings. c) Place the metal pieces in boiling water for fifteen minutes, quickly measuring them to record findings. d) Compare findings in discussion.	

V. DESIGN AND CONSTRUCTION (C.)

Estimated Time: 5-8 hours

MAJOR OBJECTIVE: To obtain knowledge and skills related to the principles of planning and design and to apply the knowledge and skills to plan, design, and construct metalwork projects and products.

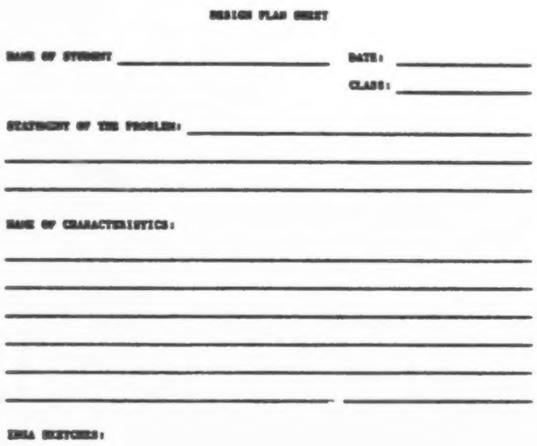
TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Integrate instruction in planning and design throughout all modules of this area of study.	
A. PLANNING FOR METALWORK The student should be able to:		
1. define planning;	Have students discuss and define planning. Point out that metalwork products/projects must be planned before being manufactured. Make students aware that planning involves two important resources, people and things, to meet human needs.	PLANNING: The process of identifying and considering details before manufacturing begins
2. develop an understanding of the importance of planning;	Point out, citing examples, that planning for various products/projects begins some time before actual work starts.	
3. identify the components of planning.	Emphasize that planning for metalwork is a cooperative process, requiring many people to use resources, equipment, and tools effectively to meet the needs of society, business, industry, and individuals. Discuss and define the components of planning.	COMPONENTS OF PLANNING 1. Formulating 2. Researching 3. Designing 4. Engineering

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Make students aware of the relationship of long- and short-term planning.	FORMULATING: The process of deciding what to manufacture to meet needs RESEARCHING: The process of gathering facts to assist with decision-making DESIGNING: The process of developing a plan to meet needs
	Emphasize the importance of scheduling and coordinating for the completion of projects and products in metalwork. Point out that improper planning can waste motion, materials, and effort, and result in higher costs.	ENGINEERING: The process of adding details to a design and of scheduling manufacturing
B. DESIGNING FOR METALWORK The student should be able to:		
1. recognize the importance of design;	Review the definition of designing. Point out that designing involves creative and original planning, rather than copying, to meet societal, industrial, business, and human needs. Encourage students to enhance their knowledge of design in metalwork by studying catalogues, magazines, and newspapers and by visiting stores and craft shops.	Exploring Industrial Arts, McGraw-Hill Ryerson, Section Two, 2-7 Metalwork, SI metric ed., Chas. A. Bennett, Unit 5 Basic Metalwork, Chas. A. Bennett, Unit 5

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
2. identify the requirements for design;	Emphasize that good design in metalwork responds to these requirements: stength, function, appearance, materials, cost, and quality.	DESIGN REQUIREMENTS 1. Strength 2. Function 3. Appearance 4. Materials 5. Cost 6. Quality
3. explain the relationship of design to strength, function, appearance, materials, cost, and quality;	Discuss the influence of design requirements on the design process, and have students consider the following questions: a) Strength--Will the design result in a strong and durable product? b) Function--Does the design fit the purpose for which it was planned? c) Appearance--Do the parts appear to belong together and is the product pleasant to look at, to live with, and to use? d) Materials--Have the materials been used effectively? e) Cost--Does the cost relate to strength, function, appearance, materials, and quality of the finished product? f) Quality--Is quality an inherent part of the finished product? Indicate that these interrelated requirements are common to all good designs.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
4. describe the basic elements of design;	Identify and then have students define each of the design elements. Point out the relationship of basic elements to design requirements and principles.	LINE: Establishes expression, leads the eye in particular directions, and outlines surfaces and contours of form SHAPE: Determines whether an object is pleasing to look at or to feel, and relies on line, colour, and surface texture SPACE: Volume, including openings, which an object occupies COLOUR: Creates special effects, such as warmth, coldness, distance TEXTURE: Indicates the surface condition, can be felt and seen, and can be related to the pattern
5. explain the principles of design;	Provide students with information about these principles of design: balance, proportion, rhythm, harmony, unity, emphasis, and variety. Make them aware that the principles can be used to organize or arrange the elements of a metalwork product so that it is pleasing to view. Have students collect illustrations and models of various types and styles of metalwork. Ask them to examine and assess the illustrations and models by answering these questions about the application of the design principles:	PRINCIPLES OF DESIGN 1. Balance 2. Proportion 3. Rhythm 4. Harmony 5. Unity 6. Emphasis 7. Variety Exploring Industrial Arts, McGraw-Hill Ryerson, Section Two Basic Metalwork, Chas. A. Bennett, Unit 5

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	a) Balance--Do the parts seem to have the same mass or value? Are the parts on each side of the centre line alike in size and shape? b) Proportion--Does the size of one part of a product relate to another part? How does the function or use of an object control its proportion? c) Rhythm--Are the elements or features such as lines, curves, forms, colours, and textures repeated? Do they give the object a pleasing appearance? d) Harmony and Unity--Do the parts of an object appear to belong together? e) Emphasis--Does the design have a point of interest? f) Variety--Are different materials, shapes, and colours used to give an interesting and lively appearance to the product?	Exploring Metalworks Basic Fundamentals, Goodheart-Willcox, Unit 3 Design and Product Planning (multi-coloured transparencies, overlays, instructor's guide), AIM Educational Aids
6. identify steps in the design process.	Provide students with information about steps pertinent to the design process, especially as these can be applied to the development of projects/products in metalwork. Encourage students to think of projects/products as design problems and to use planning sheets to answer these questions:	STEPS IN DESIGN PROCESS 1. Statement of the problem 2. Analysis and research 3. Possible solutions 4. Experimentation 5. Final solution

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	 DESIGN PLAN SHEET NAME OF STUDENT ____________ DATE: ________ CLASS: ________ STATEMENT OF THE PROBLEM: ____________ NAME OF CHARACTERISTICS: IDEA SKETCHES: a) Statement of the problem--What is the purpose of the project/product and how will it be used? b) Analysis and research--Think through the problem. What must the project do? What are the needs or characteristics? What are some of the limitations to be considered? How have others solved similar problems? c) Possible solutions--Develop ideas. What types of charts, sketches, and related labels and notes are necessary to portray the ideas and to determine the required materials? Is it necessary to improve the sketches and notes to make a better design?	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES

WORKSHEET

STUDENT ____________________ **DATE** ____________________

PROBLEM ____________________ **CLASS** ____________________

A. LIST OF PARTS

# PART NAME	MATERIAL SIZES			MATERIAL	#REQ'D	COST
	L	W	T			
1						
2						
3						
4						
5						
6						
7						
					TOTAL	

B. ORDER OF OPERATIONS

STEP	OPERATION	MACHINE OR TOOL REQ'D
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	d) Experimentation--Prepare several models or mockups of the design from paper, cardboard, soft wire, styrofoam, plasticene, or other easily manipulated material. What methods of joining and forming materials should be used? What new materials could be used to improve the design? In what ways should the design be changed or improved? e) Final solution--Develop working drawings and a work sheet related to the solution and construct the project/product. How should the drawings be used during the construction process? What parts are required? In what order should be operations be completed? Have students present their models to the class to obtain suggestions for improvements. Encourage students to compile notebook records of their own ideas and of ideas collected from periodicals, newspapers, and reference books for projects/products. Have students study publications on design to acquire more information about the relationship between projects/products and design. Make them aware that skill and knowledge acquired through experience are needed to solve design problems.	MOCKUP: A model built from a sketch to show how a project will look after it is built

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
C. PROJECT CONSTRUCTION The student should be able to:		
1. develop an understanding of the importance of sketches, working drawings, and stretchouts/patterns;	Show students examples of sketches, working drawings, and stretchouts/patterns, and explain their importance. Emphasize that sketches are diagrams portraying views and possible shapes and sizes of a product/project. Explain that working drawings, giving all the information needed to make the product, must show the following items: shape of every part, size of every part, kind of material, type of finish, and number of pieces in each part.	Metalworking, McKnight Publishing, Chapter 2 Basic Metalwork, Chas. A. Bennett, Units 6, 7 Metalwork, SI metric ed., Chas. A. Bennett, Units 5, 6, 19
	Point out that a stretchout/pattern is a full-size drawing of the product/project on a single plane. Show students examples of stretchouts/patterns of prisms, cylinders, and cones. Show them various products (or illustrations of products) made in these shapes, such as baking pans, letter trays, rectangular and square metal boxes, planters, toaster ovens, juice and soup tins, cylindrical pencil holders, funnels, cylindrical granaries and silos with cone-shaped roofs, and metal storage sheds.	Introduction and Overview, Straight Line Pattern Development, Parallel and Radial Line Pattern Development (colour filmstrips, cassettes, study guide), McIntyre Educational Media

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
2. interpret sketches, working drawings, and stretchouts/patterns;	Explain how to extract information from sketches, working drawings, and stretchouts/patterns, and provide students with opportunities to read and interpret these.	Basic Blueprint Reading and Sketching, Delmar Publishing
3. prepare sketches, working drawings, and stretchouts/patterns;	Acquaint students with diagrams, especially working drawings and stretchouts/patterns, drawn with certain kinds of lines, signs, and abbreviations. Demonstrate the procedures for preparing sketches, working drawings, and stretchouts/patterns for metalwork products/projects, and have students follow these procedures.	Simple Developments (16 mm colour film), Library, Manitoba Department of Education
4. construct and evaluate products/projects.	Have students use information on design plan sheets, work sheets, sketches, working drawings, and stretchouts/patterns to construct products/projects. Encourage them to assess the construction process, including the use of tools, and the completed product/project on the bases of planning and design principles and by comparing the input of materials, labour, energy, and other resources to the quality of workmanship and the time and money expended.	Exploring Metalworking Basic Fundamentals, Goodheart-Willcox, Unit 19

VI. CONSUMERISM (C.)

Estimated Time: 3 hours

MAJOR OBJECTIVE: To explore the economic system and the economy in relation to metalwork and consumer awareness.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Integrate instruction in consumerism and applications of consumerism to business and individuals, throughout each module in this area of study.	
A. ECONOMIC SYSTEMS AND METALWORK The student should be able to:		
1. define economic system;	Explain the term economic system, emphasizing that it refers to the following: a) The way individual workers and managers, productive organizations such as factories or farms, and government agencies are linked together to form a system, a unit, or an organization. b) The way decisions are made as to what workers, productive organizations, and government agencies will do to solve the basic economic problems each nation, province, and community faces.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Discuss the basic economic questions, pointing out their relation to metalwork businesses, services, and products and to consumers of these services and products.	BASIC ECONOMIC QUETIONS 1. What to produce? 2. How to produce it? 3. Who will receive the services and finished products? 4. How much to produce over a period of time?
	Make students aware that political, social, religious, and moral systems influence economic systems and change from one country to another and within single countries over periods of time.	
	Point out that by using and consuming resources, various economic systems produce metalwork goods and services for consumers to purchase.	
	Explain that the following economic activities provide resources for metalwork goods and services: mining, manufacturing, agriculture, and construction. Point out that individuals and businesses should select goods and services wisely and use resources effectively during the production of metalwork goods and services.	
2. explain the basic parts of economic systems;	Discuss the basics required by economic systems to produce goods and services: inputs, processes, and outputs. Make students aware of the relationship of these	BASIC PARTS OF ECONOMIC SYSTEM 1. Inputs 2. Processes 3. Outputs

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	parts to metalwork businesses, services, and products, emphasizing the following: a) Inputs are resources required for work activities to produce goods and services. b) Processes are work activities required to produce goods and services. c) Outputs are goods and services produced by an economic system. Have students give examples of inputs, processes, and outputs related to metalwork services and products.	
3. identify basic types of inputs.	Review the definition of inputs. Discuss the basic types of inputs, emphasizing that they are common to various organizations, such as schools, families, clubs, and businesses. Discuss the relationship among the basic inputs and their application to the production of goods and services for consumption by businesses, organizations, and individuals.	BASIC TYPES OF INPUTS 1. People 2. Knowledge and skills 3. Industrial resources 4. Utilities 5. Finance
B. METALWORK AND CONSUMERISM The student should be able to:		
1. identify human needs;	Make students aware of the importance of the following human needs: physical,	Looking at the Consumer, Gage Publishing

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	societal, intellectual, and emotional. Relate Maslow's hierarchy of human needs to the services and products of metalwork. Encourage students to identify basic physical, societal, intellectual, and emotional needs. Point out the relationship between these needs and metalwork activities, services, and products.	The Confident Consumer, Goodheart-Willcox MASLOW'S HIERARCHY OF HUMAN NEEDS 1. Physical needs 2. Security 3. Love and acceptance 4. Esteem 5. Self actualization
2. explain how metalwork meets human needs;	Emphasize that metalwork and related services and products are available in different societal and economic systems. Have students prepare charts, bulletin board displays, or illustrated reports explaining the needs of society, business, and individuals for different types of metalwork. Ask students to explain how the services and products provided by metalwork help society and the individual to meet these basic human needs: shelter, food, water, and clothing.	Charts Bulletin board displays
3. recognize the relationship between metalwork and the economy.	Discuss the importance of various industrial and business activities to national, provincial, regional, and local levels of the economy. Have students investigate the effects of industrial and business activities on employment and businesses related to metalwork. Make students aware that	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	industries, businesses, and individuals use the services and products of metalwork to produce other services and goods for consumption by various sectors of the economy.	
C. METALWORK AND THE MARKETPLACE		
	Point out why prospective users of the services and products of metalwork should develop an understanding of the marketplace and its relationship to the economy.	
The student should be able to:		
1. differentiate between needs and wants;	Have students compile lists of metalwork services and products desired by individuals, and have them recognize the difference between needs and wants. Make them aware of businesses that need and want services and products of metalwork.	The World of Business A Canadian Profile, Wiley Publishers of Canada, Chapter 18 NEEDS: Things required for basic life and survival WANTS: Things desired for pleasure and comfort
2. recognize the concept of quality versus cost;	Discuss the following concepts: quality versus cost, cost versus application, influence of demand on supply and cost, the state of the economy, financing, and advertising. Relate these concepts to the users and producers of the services and products of metalwork.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
3. explain the role of supply and demand;	Point out the relationship of these concepts to the following aspects of the services and products of metalwork: . planning and design; . human needs; . availability and use of resources; . employment; . availability and choice of the various services and products. Show students two metalwork products which look alike. Have them examine the products carefully to emphasize the importance of judging the value of products before buying them. Ask students to list things they would look for in buying specific metalwork products. Have them visit local stores and report on various grades and prices of metalwork articles.	
4. describe the effects of inflation;	Explain the major causes and effects of inflation. Make students aware of the effect of inflation on individuals, industries, and businesses, particularly on those industries and businesses related to metalwork.	
5. identify the positive and negative aspects of credit buying;	Discuss the advantages and disadvantages and the direct and indirect costs of credit to individuals and businesses. Have students compare the costs of items, particu-	Looking at the Consumer, Gage Publishing, Chapter 3

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	larly metalwork items, purchased on cash and credit terms by individuals and businesses.	
6. explain the purpose and influence of advertising;	Define advertising. Discuss the influence of advertising and promotion on various metalwork products and services. Have students collect information and examples related to advertising for displays and reports. Make students aware of the relationship of advertising to cost, supply and demand, and needs and wants pertinent to metalwork products. Discuss advertising psychology and propaganda and point out that attempts can be made to persuade people to buy, regardless of need or ability to pay. Encourage students to study advertisements/sales promotions carefully and to sift out propaganda and false advertising from honest sales efforts.	TYPES OF ADVERTISING MEDIA 1. Direct mail 2. Computers 3. Newspapers 4. Periodicals 5. Radio 6. Signs 7. Television
7. recognize the relationship of sources of materials to the services and products of metalwork;	Point out the relationship of sources of materials to the services and products of metalwork and to the industrial business and individual consumers of these services and products. Ask students to identify various sources of materials pertinent to metalwork products. Have students, individually or in groups, prepare charts, scrapbooks, or illustrated reports on the development of metal products from various sources.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
8. explain the consequences following from consumption of metalwork products;	Have students identify the uses of metalwork products in homes, farms, business and industry, communications, transportation, science, and medicine. Have them discuss the need for continued research related to sources of materials for metalwork.	
9. justify the need for conservation and cost consideration of materials.	Have students develop and demonstrate, through research and projects, an understanding of the importance of conservation and cost consideration pertinent to the consumption of materials by industry, business, and individuals. Ask students to consider the relationship of recycling materials to metalwork. Have them apply conservation and cost of materials to metalwork services and products.	

VII. MATERIALS (C.)

Estimated Time: 4-6 hours

MAJOR OBJECTIVE: To acquire information about the nature, source, classification, processing, and properties of metals, and to apply this information to metalwork projects and products.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Integrate instruction related to materials throughout other modules in this area of study. Emphasize the relationship of materials to safety, measurement, consumerism and conservation, design and construction, forming, fastening, conditioning, finishing, jigs and fixtures, and mass production.	
A. INTRODUCTION TO METAL MATERIALS The student should be able to:		
1. develop an awareness of the nature and source of metals;	Discuss the nature of metals by emphasizing the following: a) Metals make up half the substances found in the earth. b) Most metals are found in rock formations. c) Rocks containing metals are called ores. d) Ores are mined, broken up, crushed, and processed to remove the metal.	Modern Metalworking, Goodheart-Willcox, Unit 1 Exploring Metalworking Basic Fundamentals, Goodheart-Willcox, Unit 1

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TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Ask students to consider whether metal sources are renewable.	
2. define metals;	Show students examples of metal ores and metals and have them discuss and define metals.	METALS: Materials derived from earthy substances characterized by their luster and their capacity for electrical and heat productivity and heat fusibility OR An opaque, lustrous material, with good heat and electrical conductivity, which can be malleable, ductile, heavy, light, and strong
3. identify geographical locations of metal ores;	Refer students to maps, encyclopedias, and year books to determine world, Canadian, and Manitoban sources of various metal ores. Ask students to list the geographical locations of metal ores.	Canada Year Book
4. describe the development of mining- and metal-related industries in Manitoba;	Discuss the development of mining- and metal-related industries in Manitoba, and have students view films, prepare illustrated reports, displays, and maps, and collect newspaper clippings related to this development.	
5. recognize the importance of metals.	Have students assess and prove this statement: "Metals are everywhere around us." Ask students to work in groups on posters, bulletin board displays, or illustrated	Rolling Steel in Selkirk, Steel Rhythm (16 mm films), Library, Manitoba Department of Education

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	booklets indicating the wide use of metals in constructing roads, bridges, tunnels, and buildings, in making home appliances and home entertainment devices, jewellery, tableware, cutlery, and coins, and in manufacturing tools, farm and roadbuilding equipment, transportation vehicles, and sports equipment. Encourage students to survey their homes, schools, and classrooms, identifying the items made from metal.	
B. CLASSIFICATION OF METALS The student should be able to:		
1. identify the classifications of metals;	Point out that for identification purposes, metals fall into these classifications: ferrous metals, nonferrous metals, base metals, alloys, precious metals.	Manufacturing Processes: Metals, Prentice-Hall, Unit 1 Metalworking, McKnight Publishing, Chapter 1 Metalwork, SI metric ed., Chas. A. Bennett, Unit 7

<table>
<tr><th>TOPICS AND OBJECTIVES</th><th>SUGGESTED ACTIVITIES AND NOTES</th><th>RESOURCES</th></tr>
<tr><td>2. differentiate among the terms ferrous, nonferrous, base metals, alloys, and precious metals;</td><td>Have students discuss and define each classification term and give examples of metals in each classification. Ask them to prepare tables similar to the one following or to develop displays and illustrated booklets incorporating information from it.</td><td>FERROUS METALS: Metals with iron as their base metal
NONFERROUS METALS: Metallic materials without iron as their base metal
BASE METALS: Pure metals containing no other metals
ALLOYS: Combinations of several metals blended together while in a molten state
PRECIOUS METALS: Metals which are scarce and expensive</td></tr>
<tr><td>3. classify metals.</td><td>CLASSIFICATION OF COMMON METALS
<table>
<tr><th colspan="2">Ferrous Metals</th></tr>
<tr><th>Base Metals</th><th>Alloys</th></tr>
<tr><td>Ingot/pure iron</td><td>Cast irons</td></tr>
<tr><td></td><td>Steels</td></tr>
<tr><th colspan="2">Nonferrous Metals</th></tr>
<tr><th>Base Metals</th><th>Alloys</th></tr>
<tr><td>Aluminum</td><td>Brass</td></tr>
<tr><td>Chromium</td><td>Bronze</td></tr>
<tr><td>Copper</td><td>Nickel silver</td></tr>
<tr><td>Lead</td><td>Pewter</td></tr>
<tr><td>Magnesium</td><td>Solder</td></tr>
<tr><td>Nickel</td><td></td></tr>
</table></td><td>Metal samples from Hudson Bay Mining and Smelting Company and other sources</td></tr>
</table>

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Nonferrous Metals **Base Metals** Tin Tungsten Zinc	
	Precious Metals	
	Base Metals Gold Platinum Silver	
	Alloys Karat gold Sterling silver Coin silver	
	Encourage students to secure samples of as many metals as possible and to work in groups to mount them on hardboard, labelling and classifying each.	
C. **PROCESSING METALS**	Point out that raw materials such as ore must be processed to provide material of standard size and quality, to be used for manufacturing useful metal products.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
The student should be able to:		
1. identify the basic steps in processing base metals;	Emphasize that some ores require only a few processing steps, while others go through many: extraction from the earth, separation (removal of worthless solid materials from ores), refining (removal of impurities, which can cause metals to lose strength and other valuable properties), and fabrication of metals into various types and sizes of standard stock.	COMMON STEPS FOR PROCESSING METALS 1. Mining 2. Milling 3. Smelting 4. Refining 5. Fabricating Metalwork, SI metric ed., Chas. A. Bennett, Unit 40 Basic Metalwork, Chas. A. Bennett, Unit 2
2. explain the basic steps in processing base metals;	Ask students to research the processing of base metals. Divide them into groups to prepare reports, flowcharts, and displays on one of these topics: . Basic Steps--iron ore to finished standard stock; . Basic Steps--copper ore to finished standard stock; . Basic Steps--bauxite to finished aluminum standard stock	Manufacturing Processes: Metals, Prentice-Hall
3. develop an understanding of the production of alloy metals;	Review the definition of alloys. Enhance students' knowledge of alloy metals by having them participate in these learning activities:	Charts on steels and alloys, Drummond McCall

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	a) Discussion and emphasis of these principles: . alloys as mixtures of two or more metals or of metal and some other material, . alloys as made by mixing melted ingredients together to harden, . alloys as sometimes formed without melting; i.e., powdered mixtures of two or more metals can be heated and the fine particles joined to form a complete mass, . alloying as allowing the creation of materials with just the right combination of properties for a particular use. b) Preparation of charts illustrating alloy metals and their ingredients. c) Writing reports or answering questions on these topics: . reasons for alloying aluminum, . uses of brass and bronze, . reasons for alloying chromium with steel, . reasons for and uses of alloyed magnesium, . reasons for alloying nickel with steel.	
4. define standard stock;	Point out that the metal wholesaler carries a supply, or stock, of different kinds of metals in many sizes and shapes.	STANDARD STOCK: Common shapes and sizes in which metals are manufactured, measured, and purchased/sold

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
5. identify various shapes of common metal stock;	Show students illustrations and examples of the various shapes of common metal stock. Have them indicate some uses of common metal shapes in metalwork products and construction.	COMMON METAL SHAPES 1. Sheets 2. Plates 3. Flats 4. Perforated sheets 5. Squares 6. Pounds 7. Hexagons 8. Octagons 9. Round tubing 10 Square tubing 11. Rectangular tubing 12. Angles 13. Channels 14. Tees 15. I-Beams
6. explain the relationship of common shapes to sizes, measuring, and ordering of metal materials.	Make students aware of the common sizes of sheets, strips, plates, metal bars, structural shapes, and tubular products. Have them refer to stock lists or handbooks of materials (from companies that manufacture or sell metal supplies) to compile charts giving common sizes and measurements of metals. Encourage students to use these references when ordering materials required for projects. Emphasize that each item for order must be described accurately and clearly.	Stock lists and handbooks of metal materials

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
D. PROPERTIES AND USES The student should be able to:		
1. explain the classification of metal properties;	Point out that consideration of metal properties helps indicate the type of metal to be chosen for a specific job. Explain the classification of metal properties by demonstration and experimentation, and by discussion of these principles: a) Mechanical properties indicate how a metal reacts to various forces such as tension (pulling, stretching) and compression (squeezing). b) Physical properties result from the internal structure of metal and include density (weight for a given size), conductivity (ability to carry electricity or transfer heat), melting point (the temperature required for metal to become liquid), and coefficient of expansion (how the size of metal changes with increase in temperature). c) Chemical properties relate to how metal behaves upon contact with chemical elements such as gas or acid.	CLASSIFICATIONS OF METAL PROPERTIES 1. Mechanical properties 2. Physical properties 3. Chemical properties Metalworking, McKnight Publishing, Chapter 1 Manufacturing Processes: Metals, Prentice-Hall, Unit 1
2. define the common properties of metals;	Discuss the importance of understanding the common properties of metals, and have students list and define these properties.	COMMON PROPERTIES OF METALS 1. Density: weight of the metal 2. Corrosion Resistance: resistance to chemical action

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
		3. Hardness: resistance to penetration 4. Toughness: ability to withstand shock or heavy impact 5. Brittleness: tendency to crack or break when dropped or subjected to impact 6. Tensile Strength: resistance to being pulled apart
3. identify methods of changing properties of metals;	Acquaint students with these methods of changing the properties of metals: alloying, cold-working, and heat treating. Discuss reasons for changing properties of metals and have students carry out simple experiments to illustrate methods for changing properties.	
4. select metals according to properties for various products;	Have students identify products made from metals. Ask them to state reasons, based on properties, why different types of metals have been used in various metal products. Have them choose metals for their projects/products and explain reasons for their choices. Point out that selection of the proper materials and giving reasons for the selection are very important in industry.	
5. combine other materials with metals.	Ask students to examine metal products and to list other materials included in them. Emphasize that the inclusion of other materials makes products more interesting by adding variety to the appearance and	Metalwork, SI metric ed., Chas. A. Bennett, Unit 36

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	design. Challenge students to research and experiment with combining new materials in metalwork products, relating this activity to the principles of planning and design.	

VIII. SEPARATION (C.) Estimated Time: 6-9 hours

MAJOR OBJECTIVE: To obtain knowledge and skills related to the separation processes and to the use, care, and maintenance of hand and power tools applicable to these processes in metalwork.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Integrate instruction of separation throughout other modules in this area of study. Make students aware of its relationship to safety, measurement, materials, conservation of materials, and planning and design of products.	
A. METHODS OF SEPARATING METALS The student should be able to:		
1. define separating;	Emphasize that during the process of building/manufacturing metalwork products or components, the metal materials must be separated. Have students discuss and define separating.	SEPARATING: Shaping material by removing portions of it
2. identify methods of separating metals;	Hold a "brainstorming" session, during which students are to identify the various methods of separating metals.	METHODS OF SEPARATING 1. Shearing 2. Chipping 3. Chipless machining 4. Flame cutting

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
3. describe the methods of separating metals.	Discuss these basic principles in relation to each of the separation processes: a) Metal can be cut to the desired shape. b) Holes may be cut into a piece of metal. c) Unwanted metal can be removed from the surface of a piece of metal. d) Notches or pieces of metal can be cut from the ends or edges of metal pieces. Point out the importance of safety precautions and procedures pertinent to each of the separation methods. Ask students to define each of the methods for separating metal materials.	SHEARING: A metal-cutting or separating process done with a shear CHIP-FORMING: A metal-cutting or separating process, such as chipping, sawing, filing, grinding, and machining, during which metal chips are removed CHIPLESS MACHINING: A metal-cutting or separating process, such as chemical milling (etching), electrical discharge machining, electrochemical machining, and laser machining, during which metal is cut but no chips are removed FLAME/ARC CUTTING: A metal-cutting process done with a flame/arc cutting torch
B. HAND AND POWER TOOLS FOR SEPARATING The student should be able to:		
1. identify common hand tools for the separation process in metalwork;	Show students common hand tools (or illustrations) used in the separation processes. Have them identify each tool by name. Name the separation processes, and have students list or select the hand tools used for each.	COMMON HAND TOOLS FOR SEPARATION PROCESSES Shearing Tools Cold chisels Snips--straight, hawk-bill, aviation, circular

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
		Shears--squaring, throatless, splitting Punches--solid, hollow
2. use hand tools applicable to separation processes;	Demonstrate correct procedures for the accurate use of hand tools to perform separation processes. Provide students with opportunities to practice shearing and chipping processes on scrap metal materials. Demonstrate safety checks and proper care and maintenance of various tools. Discuss the advantages and disadvantages of hand tools.	Chipping Tools Saws--hack, coping, jeweler's Drills--hand Files--hand, flat, mill, pillar, square, round, half round, three-square, knife, warding Chisels--flat, cape, diamond, round nose Taps and Dies--standard, metric Chipless Tools Miscellaneous hand tools for etching Snips and Shears, Files (16 mm films), Library, Manitoba Department of Education Cutting Processes, Cutting Methods (colour filmstrips, cassettes, study guide), McIntyre Educational Media Straight Cutting with Snips, Laying Out and Cutting a Rectangle, Laying Out and Cutting a Square (filmstrips, cassettes, worksheets, student's guide), Nelson Canada

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
		Cutting Sheet Metal, Making Holes in Sheet Metal (filmstrips, cassettes, instructor's guide), Prentice-Hall Miscellaneous Construction Tools (colour transparencies and overlays), AIM Educational Aids
	Have students use various hand tools and materials to etch various metals. Emphasize safety.	Metalwork, SI metric ed., Chas. A. Bennett, Units 11, 12, 14 Metalworking, McKnight Publishing, Chapter 4
3. perform the separation processes with hand tools with an increasing degree of accuracy;	Demonstrate the accurate use and necessary care and maintenance of hand tools in the performance of separation processes and point out how this relates to the production of top-quality work. Give frequent performance tests covering the tools used in the separating processes.	Manufacturing Processes: Metals, Prentice-Hall, Unit 4 Basic Metalwork, Chas. A. Bennett, Units 8-10 Exploring Metalworking Basic Fundamentals, Goodheart-Willcox, Unit 6 Modern Metalworking, Goodheart-Willcox, Units 7-13
4. identify common power tools for the separation process;	Show students common power tools (or illustrations of these) for the separating processes, and have them identify each. Name the separation processes, and have students list or select the power tools used for each. Use visual and audio-visual aids to introduce power tools not available in the laboratory. Have students research and	POWER TOOLS FOR SEPARATION PROCESSES Shearing Tools Shears--bench, power squaring Punches--power-operated punches

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	prepare illustrated reports on new developments in machining tools.	Chipping Tools Saws--hack, band Drills--portable electric, drill press Files--filing machines Grinders--bench, universal Metal lathes Milling machines Chipless Machining Tools Electrical discharge machine Electrochemical machines Laser beam machines--solid, gas Electron beam machines Flame Cutting Tools Oxyacetylene welding torches Arc welding torches
5. use power tools applicable to separation processes;	Demonstrate accurate procedures for using power tools applicable to separation processes. Provide students with opportunities to practice separation processes using available power tools and scrap metal materials. Emphasize safety and care and maintenance of power tools. Demonstrate safety checks for the various power tools. Make students aware of the advantages and disadvantages of power tools.	Lathe-Chuck Work, Lathe-Work Between Centres, Machine Operations--Sheet Metal (16 mm films), Library, Manitoba Department of Education Metalwork, SI metric ed., Chas. A. Bennett, Units 12-13 Manufacturing Processes Metals, Prentice-Hall, Unit 4 Basic Metalwork, Chas. A. Bennett, Units 11-12

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
6. perform the separation processes with power tools with an increasing degree of accuracy.	Demonstrate the accurate use and necessary care and maintenance of power tools in the performance of separation processes and point out how this relates to the production of top-quality work. Give frequent performance tests covering the power tools available in the laboratory.	Modern Metalworking, Goodheart-Willcox, Units 34-39

IX. FORMING (C.)

Estimated Time: 6-9 hours

MAJOR OBJECTIVE: To gain knowledge and skills related to forming and to the use, care, and maintenance of tools and equipment applicable to various forming processes in metalwork.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Integrate instruction related to forming throughout other modules in this area of study. Make students aware of its relationship to material, design and construction of products, fastening and conditioning techniques, and mass production.	
A. METHODS OF FORMING METALS The student should be able to:		
1. define forming;	Discuss, using illustrations, and demonstrate the forming process that can be used to shape metal materials during the manufacture of metalwork products or components. Have students discuss and define forming.	FORMING: Rearranging metals to different shapes without the loss or addition of material OR Giving shape to a metal without adding or removing any portion of it
2. identify methods of forming metals.	Point out that for metals and metal products to be useful to individuals and industries, they must have certain shapes and sizes. Help students understand that requisite shapes and sizes are achieved	METHODS OF FORMING 1. Casting/Molding 2. Compressing/Stretching 3. Machining

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	through these metal forming operations: casting/molding and compressing/stretching. Explain that machining is also one of the major ways for shaping metal. Review and integrate material in Module VIII, Separation, related to machining, machine operated tools, and processes (filing, drilling, turning, grinding, shaping, and milling).	
B. CASTING OR MOLDING The student should be able to:		
1. define casting/molding;	Discuss casting/molding as a forming process in metalwork, and have students define casting/molding.	CASTING/MOLDING: The melting and pouring of a metal into a mold to produce an object of desired shape
2. recognize the importance of the casting/molding process;	Encourage students to enhance their understanding of the importance of the casting/molding process in forming metals by participating in these teaching/learning activities: . preparing a research report on the history of casting; . preparing a list of people and industries connected with metal casting in the local community and the province; . collecting illustrations and examples of castings and preparing labelled charts and classroom displays.	Metalworking, McKnight Publishing, Chapter 8 Manufacturing Processes: Metals, Prentice-Hall, Unit 2 Introduction and Overview (colour filmstrip), Foundry Work Series, McIntyre Educational Media

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
3. identify and compare the main types of casting methods;	Acquaint students with the main casting methods: sand casting, shell-mold casting, die casting, permanent-mold casting, investment casting, plaster-mold casting, and centrifugal casting.	Metalwork, SI metric ed., Chas. A. Bennett, Unit 37 Modern Metalworking, Goodheart-Willcox, Units 21-26
	Have students study classification charts related to metal casting methods and molds. Ask them to compare casting methods under these headings: mold material used, types of metals being cast, types of molds, typical products resulting from casting.	Exploring Metalwork Basic Fundamentals, Goodheart-Willcox, Unit 13 Tools and Equipment, Preparing and Pouring One-Piece Casting (Parts 1 and 2), Preparing a Split Pattern Casting (colour filmstrips and cassettes), Foundry Work Series, McIntyre Educational Media
4. cast/mold metals.	Emphasize safety precautions. Acquaint students with the tools, materials, and equipment necessary for casting. Demonstrate sand casting. Have students prepare sand castings.	Introduction and Overview, Tools and Equipment, Preparing and Pouring a One Piece Casting (Parts 1 and 2), Preparing a Split Pattern Casting, Foundry (Match Plate Pattern) (colour filmstrips, cassettes, study guide), McIntyre Educational Media

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
C. COMPRESSING AND STRETCHING The student should be able to:		
1. define compressing and stretching;	Discuss compressing and stretching as forming processes in metalwork, and have students define each term.	COMPRESSING: Forming/shaping metals by subjecting them to compressive/squeezing forces STRETCHING: Forming/shaping metals by subjecting them to tensile/stretching forces
2. compare the principles influencing compressing and stretching procedures;	Point out that metals can be formed into many shapes while hot or cold. Explain that in hot-working, metal is heated to a temperature in its hot-working range, while in cold-working, the temperature of the metal is below hot-working range. Have students discuss, research, and experiment with these principles: a) Metal forming relies on plasticity, or the ability of metals to change shape. b) The metal structure of hot-worked metals is not distorted but rearranged and the metal does not work harden. c) Metals being cold-worked become harder and stiffer as they change shape. d) Hot-working temperatures vary for each type of metal, extending from several hundred degrees below a metal's melting point up to its melting point.	HOT-WORKING: Deforming metals at high temperatures to form them into desired shapes or sizes COLD-WORKING: Forming metals at room temperature into a desirable shape Manufacturing Processes: Metals, Prentice-Hall, Unit 3

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	e) The hardness and strength of metals decrease as they are heated, and therefore less force is required to change their shape.	
	f) Machines and tools for hot-working metals must be equipped to handle hot temperatures.	
	g) Hot-working requires special safety precautions.	
	h) The hardness and strength of metals is greater at temperatures below the hot-working range, and much force is therefore required in cold-working to change a metal's shape.	
	i) Machines and tools for cold-working metals must be heavier and more ruggedly built than machines and tools for hot-working metals.	
	j) Forging improves the quality of the metal, refines the grain structure, and increases strength and toughness.	
	k) Using hot-working or cold-working processes to shape metals depends on the material being formed, the shape of the finished piece, the strength needed, and the surface finish required.	The Forging Process (colour filmstrip, cassette, study guide), McIntyre Educational Media
	l) Technological developments influence hot-working and cold-working processes.	
3. describe various methods of compressing metals;	Identify and have students define the various methods of compressing metals. Point out that these common metal-forming processes are used in industry to change the shape of metal: forging, rolling,	FORGING: Forming hot metals into desired shapes by forcing them with a hammer or press

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	extrusion, coining, powdered metallurgy.	ROLLING: Forming metals by squeezing with hot or cold rollers EXTRUSION: A metal-forming process, by which a piece of metal is forced through a die and then shaped COINING: A metal-forming proces, by which a piece of metal is squeezed between two dies POWDER METALLURGY: A metal-forming process, by which a piece of metal of a desired shape is made from metal powders
4. form metals by compression;	Emphasize safety precautions. Acquaint students with the tools, materials, and equipment necessary for forming metals by compression. Demonstrate various compression methods, depending upon the availability of tools, materials, and equipment. Have students follow the same procedures. If tools, materials, and equipment are not available for forming metals by compression, have students prepare charts, displays, and illustrated reports on the various compression methods.	Metalworking, McKnight Publishing, Chapter 5 Metalwork, SI metric ed., Chas. A. Bennett, Unit 38 Exploring Metalworking Basic Fundamentals, Goodheart-Willcox, Unit 12 Modern Metalworking, Goodheart-Willcox, Units 41, 46
5. describe various methods of stretching metals;	Identify and have students define various methods of stretching metals. Point out that these common metal-forming processes are used in industry to change the shape	DRAWING: Reducing or changing the cross-section of a piece of metal by pulling it through a die

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	of metals: drawing, stretch forming, and bending. Show students illustrations and examples of metal products formed by stretching methods; ask them to examine the products in order to identify the stretching processes used.	STRETCH FORMING: Forming sheet metal into curved surfaces BENDING: Bending metals into desired shapes either by hand or by machines Metalworking, McKnight Publishing, Chapter 6 Exploring Industrial Arts, McGraw-Hill Ryerson, Section 3, Unit 3-17
6. explain the drawing processes;	Show students examples of wire drawing and deep drawing, an have them prepare definitions, reports and displays.	WIRE DRAWING: The process of making the diameter of metal wires or rods smaller by pulling them through a die DEEP DRAWING: The process of pushing a flat sheet of metal through a hole in a die to form the sheet into a new shape
7. explain the bending processes;	Have students prepare definitions, displays, and reports on common bending processes. Show them examples of products made by these processes and have them identify the type of process used in each. Emphasize that bending metal combines stretching and compression into a single forming process. Ask students to identify the side of the bend formed by stretching and the side formed by compression.	FOLDING: A metal-forming process to prepare various folds, hems, and metal edges to receive wire and seams ROLL FORMING: The process of bending a strip or sheet of metal between rollers into almost any shape MACHINE BENDING: The process of using various bending machines and dies to bend metal bars, structural shapes, pipes, tubes, and sheet metal into various shapes and sizes

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
		HAND BENDING: The process of using various hand tools and fixtures to bend metal bars, structural shapes, pipes, and sheet metal into various shapes and sizes
8. form metals by stretching.	Emphasize safety precautions. Acquaint students with the tools, materials, and equipment necessary for forming metals by stretching. Demonstrate drawing, stretch forming, and various types of bending, depending upon the availability of tools, materials, and equipment. Have students follow these procedures to make several of the edges, seams, folds, and forms developed by various stretching processes mentioned in this module. If tools, materials, and equipment are not available for forming by stretching, have students prepare charts, and illustrated reports on various stretching methods.	Metalwork, SI metric ed., Chas. A. Bennett, Units 17, 18, 19 Manufacturing Processes: Metals, Prentice-Hall, Unit 3 Modern Metalworking, Goodheart-Willcox, Unit 19 Drilling, Forming and Bending - Part One, Forming and Bending - Part Two (colour filmstrips, cassettes, study guide), McIntyre Educational Media Squaring and Bending (filmstrips, cassettes, student guide), Nelson Canada

E. CONDITIONING (C.)

Estimated Time: 2 hours

MAJOR OBJECTIVE: To recognize the significance and gain understanding of the common methods of conditioning and to apply this understanding to various conditioning processes in metalwork.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Integrate conditioning, where applicable, throughout other modules in the metalwork area of study. Emphasize the relationship of conditioning to safety, measurement, consumerism, design and construction, forming, fastening, and mass production.	
A. INTRODUCTION TO CONDITIONING The student should be able to:		
1. define conditioning;	Have students discuss and define conditioning. Point out that internal changes occurring as the result of the conditioning process do not usually show on the outside of the metal as they do in casting/molding, compressing, or stretching processes.	CONDITIONING: The process of forming standard stock by changing its internal structure without making any change in its external structure
2. develop an understanding of the importance of conditioning;	Discuss, demonstrate, and use illustrations and samples to emphasize these concepts: a) Conditioning allows many different products to be made from many different kinds of standard stock.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	b) Standard stock can be processed more easily as a result of conditioning. c) Conditioning of standard stock adds special qualities or features to it, so that the finished product does a better job. d) Hardness, a feature which can be changed by conditioning, is important for metal parts that must not wear out fast. e) Conditioning of standard stock can increase its ductility and strength. Ductility refers to how easily a piece of standard stock can be stretched or compressed; strength, to how well a piece of standard stock can stand up under stress or strain.	
3. describe the internal structure of standard stock;	Use discussion, diagrams, and experiments to acquaint students with the internal structure of standard stock. Emphasize these principles: a) The internal structure of standard stock is made up of crystals or cells known as grains. b) Round and widely spaced grains cause the metal to be ductile and not very strong. c) Small and flattened-out grains result in the metal being strong and not very ductile.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
4. identify common conditioning processes;	Emphasize that methods of conditioning developed technologically to meet the needs of people and industry at a particular time in history.	COMMON CONDITIONING PROCESSES 1. Thermal conditioning 2. Mechanical deforming 3. Chemical reactions 4. Physical conditioning
	Acquaint students with these common conditioning processes: thermal conditioning, mechanical deforming, chemical reactions, and physical conditioning. Have students discuss and define each process.	THERMAL CONDITIONING: The process of changing properties of metals through the addition and withdrawal of heat in various amounts, sequences, and lengths of time
	Have students research and discuss the various times in the manufacturing cycle that conditioning takes place. Emphasize these concepts:	MECHANICAL DEFORMING: The process of changing properties of metals through working metals at various temperatures
	a) Some conditioning occurs near the beginning of the manufacturing process to get standard stock ready for mechanical deforming, machining, and other processes. b) Some conditioning, called in-process conditioning, happens part way through the manufacturing cycle. c) Some conditioning, called end-process conditioning, occurs at or near the end of the manufacturing cycle.	CHEMICAL REACTIONS: The process of changing properties of metals by inducing a rearrangement of atoms to produce products chemically different from the original metal stock PHYSICAL CONDITIONING: The process of changing the molecular structure of metals by applying direct electrical current to metals

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
5. develop an understanding of the relationship between conditioning and the properties of metals.	Point out that metals and conditioning processes are appropriate to specific projects dependent upon their chemical, mechanical, physical, and electrical properties. Ask students to identify the properties of metals.	
B. THERMAL CONDITIONING		
The student should be able to:		
1. explain the importance of thermal conditioning;	Review the definition of thermal conditioning. Emphasize that hot-treating or thermal conditioning allows for these requirements to be met: a) Metals must be soft enough to machine. b) Metals must be hard enough to perform the jobs for which they are intended.	
2. identify thermal conditioning processes;	Acquaint students with these thermal conditioning processes: annealing, case hardening, hardening, and tempering. Discuss these processes and have students gain an understanding of them by participating in these activities: . defining each process; . researching each process; . viewing films/filmstrips about each process;	Modern Metalworking, Goodheart-Willcox, Unit 31 Exploring Metalworking Basic Fundamentals, Goodheart-Willcox, Unit 15 Metalwork, SI metric ed., Chas. A. Bennett, Unit 39

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	. observing various heat-treating processes in the school shop; . visiting industries to observe and report on heat-treating processes; . preparing charts, displays, and illustrated reports on each thermal conditioning process; . experimenting with the effects of heat treatment on metals and reporting findings; . preparing labelled displays of metal products which have been heat treated; . researching recent developments, such as flame hardening, induction hardening, and laser and electron beam hardening; . identifying metal products in homes, schools, and forms conditioned thermally.	
3. condition metals by the thermal conditioning processes.	Review the need to follow safety procedures and precautions. Emphasize that thermal conditioning includes a number of processes involving controlled heating and cooling of metals to obtain certain desirable changes in their properties. Demonstrate and provide students with opportunities to practice the various processes of thermal conditioning.	Elements of Hardening, Elements of Surface Hardening, Elements of Tempering, Normalizing, and Annealing (16 mm colour films), Library, Manitoba Department of Education

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
C. MECHANICAL DEFORMING The student should be able to:		
1. explain the importance of mechanical deforming;	Review the definition of mechanical deforming. Emphasize that the main purpose of mechanical deforming is to form standard stock into a product or product-part, and that stock is often conditioned while being formed.	
2. identify the mechanical deforming processes;	Acquaint students with these mechanical deforming processes: hot-working and cold-working. Discuss each process and have students participate in these activities: . defining each process; . researching each process; . viewing audio-visuals about each process; . observing each process in industry and, where possible, in the school shop; . preparing charts, displays, and illustrated reports on hot-working and cold-working; . experimenting with the effects of hot-working and cold-working metals and reporting findings; . preparing labelled displays of metal products which have undergone hot-working and cold-working.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
3. condition metals by using the mechanical deforming processes.	Review the need to follow safety procedures and precautions. Demonstrate and provide students with opportunities to practice hot-working and cold-working of metals, such as hammering pieces of aluminum or copper. Have students bend metals, and point out that hammered aluminum or copper is stiffer than unhammered aluminum or copper due to the compression of the metal molecules.	Peening, Finishing and Assembly (colour filmstrip, cassette, study guide), McIntyre Educational Media
D. CHEMICAL REACTIONS The student should be able to:		
1. explain the importance of chemical reactions;	Review the definition of chemical reactions. Emphasize that chemical reactions bring about a new arrangement of atoms, producing metal products with characteristics quite different from the original metal products.	
2. develop an understanding of the chemical reaction process in alloying.	Discuss how alloying changes the mechanical and physical properties of the combined base metals. Make students aware that other elements can be added to the metals to bring about a chemical reaction to change their properties. Explain and have students research these principles:	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	a) Magnesium added to aluminum results in an aluminum alloy which can be welded. b) Copper added to aluminum produces an aluminum alloy with machinability. c) Silicon added to aluminum results in an aluminum alloy capable of being casted. d) Nickel added to steel provides an alloy with increased strength and toughness and helps steel to resist corrosion. e) Chromium adds hardness, toughness, and resistance to wear to steel. f) Manganese used in steel produces a clean metal, adds strength, and helps in heat treating of metal. g) Silicon added to steel causes an increase in resiliency. h) Tungsten used with chromium, vanadium, molybdenum, or manganese as additives to steel produces high-speed steel. i) Molybdenum adds toughness and higher strength to steel. j) Vanadium improves the grain of the steel. k) Copper added to gold makes gold harder so it will wear longer. l) Copper and zinc added to silver lowers its melting point for use as silver solder. m) Copper and zinc form brass when combbined. n) Copper and tin form bronze when combined.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Have students make a display using samples to show the different alloys of aluminum and steel. Ask them to survey their homes to identify products conditioned by chemical reaction.	
E. PHYSICAL CONDITIONING The student should be able to:		
1. explain the importance of physical conditioning;	Review the definition of physical conditioning. Point out that only a few physical conditioning processes are used to make metal parts or products.	
2. condition metals by using a physical conditioning process.	Discuss how a piece of steel can be magnetized to become a compass needle. Point out that it must be magnetized before being assembled with other compass parts. Have students magnetize metals or metal products, such as the tip of a screwdriver. Emphasize that magnetizing is a physical change brought about by the physical conditioning process.	

XI. FASTENING (C.) Estimated Time: 10-12 hours

MAJOR OBJECTIVE: To obtain knowledge and skills related to the methods, tools, equipment, and materials applicable to mechanical, adhesion, and cohesion fastening procedures in metalwork.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Integrate instruction in fastening throughout the modules in the metalwork area of study. Point out the relationship of fastening to safety, measurement, consumerism, materials, design and construction, forming, finishing, conditioning, and mass production.	
A. METHODS OF FASTENING METALS The student should be able to:		
1. define fastening;	Have students discuss and define fastening.	FASTENING: The process of binding, connecting, securing, holding, attaching, and/or affixing one item to another OR The process of joining two or more pieces of metal together by bolts, rivets, welding, and adhesives

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
2. develop an understanding of the importance of fastening;	Use illustrations, samples, and demonstrations to discuss these concepts: a) Metal products are usually made up of more than one part. b) The selection of the proper metal-fastening technique for a given metal product is extremely important. c) The time required to assemble metal parts is affected by the fastening method. d) The cost of the assembled product is influenced by the metal-fastening technique used. e) The final strength and safety of a metal product is directly related to the way its parts are fastened together. f) A metal product can be unsafe or unworkable if the wrong metal-fastening technique is used. g) Fastening is one facet of the assembling process of metalwork products.	Manufacturing Processes: Metals, Prentice-Hall, Unit 5 Assembly and Fastening (colour filmstrip, cassette, study guides), McIntyre Educational Media
3. identify methods of fastening.	Emphasize that methods of fastening and types of fasteners have been influenced by needs of people at a particular time in history and by technological developments. Have students work in groups to trace the development of fastening methods.	Riveting, Soldering, and Forming Seams (transparencies and duplicating masters), Arnold-Nasco

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Acquaint students with these fastening methods used on metalwork products: mechanical, adhesion, and cohesion. Ask students to define each method.	MECHANICAL FASTENING: Joining of two or more pieces of metal with the help of screws, bolts, rivets, keys, retaining rings and pins, and seams ADHESION FASTENING: Joining accomplished with the aid of an adhesive COHESION FASTENING: Joining used to put two or more pieces of metal together with the help of heat
B. MECHANICAL FASTENING The student should be able to:		
1. identify methods of mechanical fastening;	Review the definition of mechanical fastening. Discuss and have students locate examples and illustrations of these types of mechanical fastening used in metalwork: threaded fastening, non-threaded fastening, and seam fastening.	Manufacturing Processes: Metals, Prentice-Hall, Unit 5 Fasteners (multicolour transparencies, overlays, instructor's guide), AIM Educational Aids
2. describe the purpose of threaded fastening;	Discuss these reasons for using threaded fastening in metalwork products: a) The product can be taken apart for repairs and reassembled without damaging any of the parts. b) The threaded parts can be used to make fine adjustments.	Metalwork, SI metric ed., Chas. A. Bennett, Unit 16 Basic Metalwork, Chas. A. Bennett, Unit 21 Metalworking, McKnight Publishing, Chapter 9

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TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	c) The threaded parts can exert force through movement.	
3. recognize various types of threaded fasteners;	Point out that threaded fasteners are made in many shapes and sizes, from different kinds of metals, and with various types of finishes. Acquaint students with common threaded fasteners, and ask them to participate in these teaching-learning activities: . preparation of labelled panel displays of threaded fasteners; . preparation of reports on the uses of threaded fasteners; . preparation of reports/diagrams on the types/shapes of heads of threaded fasteners; . preparation of research projects on how threaded fasteners are manufactured; . participation in identification tests.	COMMON THREADED FASTENERS 1. Cap screws 2. Machine bolts 3. Machine screws 4. Set screws 5. Stud bolts 6. Self tapping screws 7. Thread cutting screws
4. use threaded fasteners;	Acquaint students with the tools necessary for turning and holding threaded fasteners. Point out the need to match tools to the threaded fasteners and to care for and maintain tools effectively. Demonstrate and have students follow the procedures for fastening metal products with various threaded fasteners. Emphasize safety precautions.	COMMON TOOLS FOR THREADED FASTENERS 1. Pliers--slip joint, side cutting, long nose 2. Screwdrivers--plain, Phillips head 3. Wrenches--monkey, adjustable, pipe, open-box end, socket, allen

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
5. explain the purpose of non-threaded fastening;	Point out that non-threaded fastening serves many purposes in metalwork, such as positioning shafts and brackets, helping to prevent pulleys and gears from turning on shafts, aligning parts, and providing permanent fastening.	Manufacturing Processes: Metals, Prentice-Hall, Unit 5
6. recognize the various types of non-threaded fasteners;	Make students aware that non-threaded fasteners, in many shapes and sizes, are made from different types of metals and with various kinds of finishes. Acquaint students with common non-threaded fasteners and encourage them to participate in these teaching-learning activities: . preparation of labelled panel displays of non-threaded fasteners; . presentation of oral reports and participation in "show and tell" sessions on the uses of various types of non-threaded fasteners; . preparation of reports and diagrams of shapes and heads of non-threaded fasteners, especially rivets; . preparation of research projects on how non-threaded fasteners are manufactured; . participation in identification tests.	COMMON NON-THREADED FASTENERS 1. Keys 2. Pins--cotter, dowel, roll, taper 3. Rivets--flat, countersunk, pan, truss, round, button, cone, flat top countersunk, round top countersunk Modern Metalworking, Goodheart-Willcox, Unit 18 Exploring Metalworking Basic Fundamentals, Goodheart-Willcox, Unit 8 Metalwork, SI metric ed., Chas. A. Bennett, Unit 28 Exploring Industrial Arts, McGraw-Hill Ryerson, Section Three, 3-24
7. use non-threaded fasteners;	Emphasize safety procedures and precautions. Point out the need to match tools to the non-threaded fasteners and to care for tools effectively. Demonstrate and have	COMMON TOOLS FOR NON-THREADED FASTENERS Drills Pliers

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	students follow the procedures for fastening metal products with various types of non-threaded fasteners.	Punches Punch and die sets Hammers--ball peen, rivet Rivet sets Pop riveter Riveting and Fastening (colour filmstrips, cassettes, program guide), Prentice-Hall Media
8. explain the purpose of seam fastening;	Have students locate examples and illustrations of the various types of seams used to join two pieces of sheet metal in metalwork products.	Metalwork, SI metric ed., Chas. A. Bennett, Unit 27 Metalworking, McKnight Publishing, Chapter 6 Basic Metalwork, Chas. A. Bennett, Unit 24 Manufacturing Processes: Metals, Prentice-Hall, Unit 3
9. recognize common types of sheet metal seams;	Acquaint students with common types of sheet metal seams by having them participate in activities and projects like these: • preparing bulletin board displays and charts showing sheet metal seams; • preparing reports and diagrams of sheet metal seams; • presenting oral reports on the uses of various types of sheet metal seams;	COMMON TYPES OF SHEET METAL SEAMS 1. Butt 2. Lap 3. Corner lap 4. Lap with joggle 5. Folded 6. Grooved Modern Metalworking, Goodheart-Willcox, Unit 19

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	. making large scale models of the most common sheet metal seams, using heavy cardboard if sheet metal is not available; . participating in identification tests.	Exploring Metalworking Basic Fundamentals, Goodheart-Willcox, Unit 9
10. join sheet metal with various types of seams.	Emphasize safety procedures and precautions and acquaint students with proper use, care, and maintenance of requisite tools and equipment. Demonstrate seam fastening procedures and have students join sheet metal with various types of common seams.	Seams and Joints (colour filmstrips, cassettes, program guide), Prentice-Hall Media Hand Seams, Machine Seams (sound filmstrips, student guide), Nelson Canada
C. ADHESION FASTENING		
The student should be able to:		
1. identify methods of adhesion fastening;	Review the definition of adhesion fastening. Acquaint students with these methods of adhesion fastening: adhesive bonding, soft soldering, and brazing. Show students examples of each type of adhesion fastening.	
2. define adhesive bonding;	Discuss and have students define adhesive bonding.	ADHESIVE BONDING: Fastening metals with adhesives such as cements and glues
3. reognize the advantages and disadvantages of various types of adhesives;	Acquaint students with various types of adhesives. Ask them to prepare research reports on the advantages and disadvantages of these various types.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
4. join metals by the adhesive bonding process;	Emphasize safety precautions to be followed when using glues and cements. Acquaint students with the tools and steps required to produce bonded joints. Have students use these steps to produce solid bonded joints in metalwork products: a) Surface preparation--Emphasize that all adhesives require clean surfaces to produce full strength bonds and that the cleaning process may range from simply wiping surfaces with solvent to multi-stage cleaning and chemical treatment. b) Adhesive preparation--Discuss setting up equipment, mixing procedures, and delivery of the adhesive to the work area. c) Adhesive application--Point out the proper ways to use brushes, rollers, sprays, dipping, and other methods. d) Assembly--Show how to position materials to be joined and how to use jigs to align materials. e) Bond development--Explain reasons for the curing of adhesives, the evaporation of solvents, the application of pressure and/or heat, and other types of bond development. Ask students to test the strength of various glues and cements, and provide them with opportunities to use various adhesives in metalwork products/projects.	STEPS TO PRODUCE SOLID BONDED JOINTS 1. Surface preparation 2. Adhesive preparation 3. Adhesive application 4. Assembly 5. Bond development

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
5. define soft soldering;	Have students discuss and define soft soldering. Show them examples of metalwork products assembled by using the soft soldering process.	SOFT SOLDERING: A metal joining process using low-melting point solder
6. recognize the importance of soft soldering;	Point out that soft soldering is an important method applicable to metal construction and fastening in industry. Ask students to locate examples of metal products which contain many soldered parts.	
7. identify soldering conditions;	Have students research the reasons for each of these conditions which must be met before two metals can be joined: a) The correct solder alloy must be used. b) The proper flux must be applied. c) An adequate source of heat must be available. d) The surfaces to be soldered must be clean.	
8. describe the equipment, solders, and fluxes for the soldering process;	Have students prepare displays of the various types of equipment, solders, and fluxes used in the soldering process. Ask students to determine answers to these questions: a) What kinds of heating devices are used for soldering? b) What types of solder are used in the soldering process?	Solder and Soldering (16 mm colour film), Library, Department of Education

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	c) What is the purpose of a flux? d) What is meant by tinning copper? How is this done?	
9. fasten metal by the soldering process;	Point out the safety precautions. Demonstrate the procedures for achieving successfully soldered joints in flat metal and cylinders, and during the sweat soldering process, emphasizing these requirements: a) Have a clean, well-fitting joint. b) Use a well-tinned copper or iron. c) Have adequate heat so the metal being soldered will melt the solder. d) Use the proper type and amount of flux. e) Apply the correct amount of solder to the joint. Provide students with opportunities to apply knowledge and skills in the soft soldering process to their metalwork products/projects.	<ins>Soldering: Introduction and Vocabulary</ins>, <ins>Soldering: Miscellaneous</ins>, <ins>Soldering: Sheet Metal Techniques</ins> (colour-sound filmstrips), AIM Educational Aids
10. define <ins>brazing</ins>;	Have students discuss and define <ins>brazing</ins>. Point out that brazing, often referred to as hard soldering, forms very strong joints and allows joints to be formed between like and unlike metals; it is good for repairing broken parts, since it does not melt surrounding parts.	<ins>BRAZING</ins>: The process of joining two or more pieces of metal with the help of a metal-brazing metal

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
11. identify the equipment and supplies for brazing;	Show students examples and illustrations and have them prepare labelled displays of various equipment, brazing rods, fluxes, and torches. Point out that rods and fluxes can be purchased for brazing on many metals at many temperatures.	
12. use the brazing process to join metals;	Emphasize requisite safety precautions. Demonstrate the procedure for brazing, placing special emphasis on the following: a) Make sure the parts to be joined are very clean and free of impurities. b) Heat the metals with a torch until they are red hot. c) Heat the end of the rod and dip it into the flux. d) Hold the rod just ahead of the flame. e) Apply heat until the flux melts. f) Avoid overheating, and do not let the flame strike the rod directly and melt it. Provide students with the opportunity to practice brazing of simple joints on scrap metals. Ask each student to complete a project that includes brazing as a fastening method.	
13. compare the brazing process with soft soldering and welding processes.	Make students aware of these differences between brazing and soft soldering: brazing results in a stronger joint, requires a tighter fitting joint and more heat, uses	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	heat (usually from a flame or torch), and requires more expensive fluxes. Point out these differences between brazing and welding: brazing does not melt base metals, but another piece of metal, called a brazing rod, onto the edges of the pieces to be joined, and causes a joint to form when the molten metal hardens.	
D. COHESION FASTENING The student should be able to:		
1. define cohesion fastening;	Have students discuss and define cohesion fastening.	COHESION FASTENING: A joining process used to put two or more pieces of metal together with the help of heat so that the pieces are melted at the point of joining and forced together
2. define welding;	Ask students to define welding, after they have discussed and researched it. Show them samples and illustrations of these five basic welding joints: corner, edge, butt, lap, and tee.	WELDING: A cohesion process, joining two or more metal pieces by heat and pressure
3. describe oxyacetylene, arc, and resistance welding processes;	Have students learn about the oxyacetylene, arc, and resistance welding processes by participating in these activities: . visiting local industries that use	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	welding in the manufacture and servicing of cycles; . inviting professional welders to discuss and demonstrate welding procedures; . researching information about each of the welding processes.	
	Make students aware of the influence of technology on welding.	Welding (16 mm film), Library, Manitoba Department of Education
4. fasten metals with the welding process.	Emphasize safety precautions. Demonstrate the proper techniques and have students use them in these teaching-learning activities: . preparation of basic weld joints by oxyacetylene and electric arc welding; . completion of a piece of work using resistance welding; . completion of products/projects incorporating various types of welding processes. Encourage students to assess the quality of all their welding samples and projects.	

XII. FINISHING (C.)

Estimated Time: 3-6 hours

MAJOR OBJECTIVE: To acquire information and skills related to a number of finishing processes in metalwork and to perform these processes using tools and equipment with increasing accuracy.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Integrate instruction in finishing throughout other modules in the metalwork area of study. Emphasize the relationship of finishing to safety, careers, consumerism, design and construction, forming, conditioning, fastening, and mass production.	
A. INTRODUCTION TO FINISHING The student should be able to:		
1. define finishing;	Have students discuss and define finishing.	FINISHING: Surface treatment of metals done to improve appearance and to protect the surface from deterioration
2. develop an understanding of the importance of finishing;	Discuss, using illustrations, samples, and audio-visuals, the following purposes of finishing metalwork: . to improve the appearance of the product; . to prevent corrosion; . to cover less expensive metal to enhance its value; . to improve the wearing quality of metal surfaces;	Manufacturing Processes: Metals, Prentice-Hall, Unit 6 Metalworking, McKnight Publishing, Chapter 10

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	. to neutralize the reaction of metal to certain chemicals; . to protect the surface; . to beautify the surface; . to improve electrical conduction.	
	Point out that most metal products manufactured by modern industry require some kind of finishing.	
3. identify the categories of metal finishes.	Emphasize that the categories of metal finishes have evolved to meet the needs of industrial and technological processes, products, and developments.	
	Point out that all metal finishing processes may be grouped into these three major categories:	
	. adding material to metal surface by combining processes; . removing material from metal surface by separating processes; . giving some mechanical treatment to the metal surface by forming processes.	FINISHING BY COMBINING: Adding materials, generally called finishes, to other materials is a finishing process required on materials not having the desired colour or inherent lasting qualities
	Show students examples of each category and ask them to identify the many kinds of finishes, often two or more, used on common metal products.	FINISHING BY SEPARATING: Obtaining a desired surface texture by removing material FINISHING BY FORMING: Obtaining a desired surface texture through pressure

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
B. ADDING MATERIALS TO METAL SURFACE The student should be able to:		
1. identify the various types of surface coatings;	Acquaint students with the types of surface coatings and have them prepare classroom and bulletin board displays of each. Emphasize these coating materials: a) Organic--lacquers, enamels, paints, and waxes b) Inorganic--ceramic glazes and procelain coatings; c) Metallic--plating metals with desirable metals such as chrome, silver, tin, nickel, by dipping or electroplating.	SURFACE COATINGS 1. Clear lacquer 2. Wax 3. Coloured lacquer and paints 4. Enamels 5. Metals 6. Plastics 7. Coloured metallic oxide
2. develop an understanding of the purpose of each type of surface coating;	Discuss the purpose of the coating material used on the surfaces of metalwork products, and have students research relevant sources (including manufacturers' literature) and prepare displays, illustrated reports and oral presentations on this subject.	
3. describe the characteristics of coating materials;	Discuss these characteristics: good weatherability, pigmentation clarity and permanence, penetrating qualities, resistance to corosion, adhesive qualities, sheen, and flowability. Have students prepare reports on these characteristics.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
4. recognize the significance of surface preparation;	Have students prepare reports on the need for cleaning metal surfaces prior to applying coatings. Demonstrate safe procedures for using various cleaning products, and give students opportunities to use them.	Basic Metalwork, Chas. A. Bennett, Unit 25
5. finish metalwork products by adding material to the surface.	Emphasize safety procedures and precautions when showing students the various techniques, tools, and equipment for applying lacquers, paints, enamels, waxes, and plastics to metals, for electroplating and dipping metals, and for using heat to coat metals with a coloured metallic oxide. Emphasize these systems for applying coatings: brushing, rolling, spraying, dipping, electroplating, and laminating. Demonstrate the procedures for applying finishes, and for using and maintaining tools and equipment. Provide students with opportunities to practice coating small samples of various metals and have them use coating techniques to finish their metal products/projects.	Basic Metalwork, Chas. A. Bennett, Unit 26 Metalwork, SI metric ed., Chas. A. Bennett, Units 26, 34, 35 Metalworking, McKnight Publishing, Chapter 10 Basic Metalwork, Chas. A. Bennett, Unit 26 Manufacturing Processes: Metals, Prentice-Hall, Unit 6 Metal Coatings (colour filmstrip, cassettes, teacher's manual, reproducible masters), Singer Career System

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
C. REMOVING MATERIAL FROM SURFACE		
The student should be able to:		
1. identify various methods of finishing by removing material from the surface;	Have students discuss and define these methods of finishing that involve removing material from a metal's surface: polishing and buffing.	POLISHING: The process of finishing metal by fine grinding, producing a smooth and glossy surface by friction BUFFING: The process of finishing which further smooths the metal by bringing out a high luster
2. develop an understanding of the importance of each method of finishing by removing material from the surface;	Show students metal products finished by polishing and buffing. Ask students to determine the importance of polishing and buffing by researching literature, viewing audio-visuals and demonstrations, visiting metalwork shops, and listening to talks presented by metalwork craftsmen. Point out that polishing and buffing improve the appearance and durability of metal products.	Metalwork, SI metric ed., Chas. A. Bennett, Unit 33 Metalworking, McKnight Publishing, Chapter 10 Basic Metalwork, Chas. A. Bennett, Unit 16
3. finish metal products by removing material from the surface.	Emphasize safety precautions and procedures when showing students the tools, equipment, and supplies necessary for finishing metals by polishing and buffing. Discuss the care and maintenance of tools, equipment, and supplies. Demonstrate polishing and buffing by hand and by machine.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Allow students to practice hand and machine polishing and buffing techniques on small samples of metals and to incorporate these techniques into metalwork products/projects.	
D. MECHANICAL TREATMENT TO METAL SURFACE The student should be able to:		
1. identify various mechanical treatment methods of finishing metal surfaces;	Have students define these methods of finishing metal surfaces by mechanical treatment methods: planishing, fluting, doming, overlaying, tapping, chasing, tooling/embossing, and etching. Point out and have students locate metal products finished by planishing, fluting, doming, overlaying, tapping, chasing, tooling/embossing, and etching.	PLANISHING: Process of finishing or smoothing the surface of sheet metal by applying a hammer with a mirror-smooth face to it FLUTING: Process of finishing by which grooves are formed on the sides and edges of bowls, plates, and plate-like metal objects DOMING: Process of finishing by shaping feet on metal products, such as bowls, trays, or planters OVERLAYING: Process of finishing by fastening a metal device to a metal piece for decorative purposes

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
		TAPPING: Process of finishing by outlining a pattern on the surface of sheet metal with a sharp-pointed tool and decorating the background with various types of punches CHASING: Process of finishing by working a design on the metal surface with small chisel-like tools and punches TOOLING/EMBOSSING: Process of finishing by raising a pattern on thin metal ETCHING: Process of finishing by applying dilute acid solution to metal to provide a dull, slightly roughened surface OR Marking or decorating metal by using acid to eat into the metal
	Have students increase their knowledge of mechanical treatment methods of finishing metal by participating, individually or in groups, in activities like these: . preparing displays; . preparing oral and written reports; . visiting metalwork industries; . listening to talks by metalcraft workers.	Metalwork, SI metric ed., Chas. A. Bennett, Units 22, 23, 24, 25

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
2. develop an understanding of the importance of mechanical treatment methods for finishing metal surfaces;	Have students, individually or in groups, prepare charts, displays, and reports on the purpose of mechanical treatment methods for finishing metal surfaces.	Peening, Finishing, and Assembly, Introduction and Overview, Sinking and Raising, Heat Treating, Annealing, and Colouring, Metal Spinning--Part 1 and 2, Decorating and Etching, Decorative Metal Work--The Making of an Etched Bracelet, Copper Enameling (colour filmstrips, cassettes, study guide), McIntyre Educational Media Enameling (colour filmstrips, cassettes, study guide) McIntyre Educational Media
3. finish metalwork with mechanical treatment methods.	Emphasize safety precautions and procedures related to each of the mechanical treatment methods for finishing metalwork surfaces. Acquaint students with the tools, equipment, and supplies necessary to perform each of the mechanical treatment methods. Discuss care and maintenance of tools, equipment, and supplies. Demonstrate and have students practice each of the finishing methods. Encourage students to incorporate the mechanical treatment methods into metalwork products/projects.	

XIII. JIGS AND FIXTURES (C.)

Estimated Time: 3 hours

MAJOR OBJECTIVE: To recognize the significance of jigs and fixtures, gaining knowledge and skills related to designing, constructing, testing, and refining jigs and fixtures for use in manufacturing metalwork products.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Integrate instruction in jigs and fixtures throughout other modules in this area of study. Emphasize the relationship of jigs and fixtures to safety, careers, consumerism, design and construction, forming, conditioning, fastening, finishing, and mass production.	
A. INTRODUCTION TO JIGS AND FIXTURES The student should be able to:		
1. define jig;	Show students jigs (or illustrations of these), and have them define the word jig.	JIG: A device that holds work in position and positions and guides the cutting tool OR A device that holds metal to be cut or bent and guides the tool used
2. define fixture;	Show students fixtures (or illustrations of these), and have them define the word fixture.	FIXTURE: A device for holding a piece of work in a machine but not guiding the machine tool

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
		OR A device used to hold metal while it is being machined
3. recognize the need for jigs and fixtures.	Make students aware of these concepts: a) Metal products and their parts were hand crafted (rather than mass produced) during the early days of manufacturing. b) Mechanical holding devices, such as simple clamps, originated to free the craftsman's hand. c) The advent of mass production necessitated the evolution of simple devices, such as clamps, into a multitude of specialized jigs and fixtures. d) Mass production, permitting the manufacture of large numbers of similar and interchangeable units, could not exist without jigs and fixtures. Help students to learn about the need for jigs and fixtures by having them participate in activities like these: . writing research reports on Eli Whitney and his invention of a jig to mass produce muskets; . dramatizing skits on Eli Whitney and his invention;	Manufacturing: A Basic Text for Industrial Arts, McKnight Publishing, Topic 25, Chapter 10 Introduction to Manufacturing, Delmar Publishers, Unit 21 Manufacaturing: Industry and Careers, Prentice-Hall, Unit 5 World of Manufacturing, McKnight Publishers, Reading 25

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	. writing research reports or presenting oral reports on Chauncy Jerome and his use of jigs and fixtures in mass producing brass clocks; . visiting metal work and related industries to observe the use of jigs and fixtures; . preparing displays of metalwork products and their parts which have been mass produced; . comparing a metalworking activity done by hand to the same activity done with the aid of jigs and fixtures; . preparing displays and reports on the influence of technological and industrial developments and research on jigs and fixtures.	
B. TYPES OF JIGS AND FIXTURES The student should be able to:		
1. identify types of jigs;	Review the definition of jig. Show students these jigs (or illustrations of them): open, closed, indexing or rotary, combination, and boring.	TYPES OF JIGS 1. Open 2. Closed 3. Indexing or rotary 4. Combination 5. Boring

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
2. explain the function of each type of jig;	Acquaint students with these functions of each type of jig: a) Open jig--Used to locate holes for drilling, this is the simplest type of jig, consisting of a metal plate with holes to guide the drill. b) Closed jig--The part being worked on is placed in the jig, accurately located, and clamped in place for several drilling operations. c) Indexing or rotary jigs--Used to drill holes at various angles, these jigs can hold several parts at once. The part to be worked on is moved, either manually or automatically, for the required drilling operations. d) Combination jig--This jig is capable of performing several different operations. e) Boring jigs--These jigs are used for machining large holes. Have students prepare displays and reports/presentations on the various types of jigs.	
3. identify types of fixtures;	Review the definition of fixture. Show students these fixtures (or illustrations of them): milling fixtures, fixtures for circular saw operation, band saw fixtures, sanding fixtures, boring fixtures, welding fixtures, and gauging fixtures. Point out that fixtures are classified according	TYPES OF FIXTURES 1. Milling fixtures 2. Fixtures for circular saw operation 3. Band saw fixtures 4. Sanding fixtures 5. Boring fixtures

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	to the type of machine on which they are used.	6. Welding fixtures 7. Gauging fixtures
4. explain the function of each type of fixture.	Acquaint students with the functions of each type of fixture. Emphasize that fixtures can be designed to hold several parts, to rotate so several operations can be performed, and to perform two or more operations. Ask students to prepare displays and illustrated reports to describe the function(s) of each type of fixture.	
C. JIG AND FIXTURE DESIGN		
The student should be able to:		
1. develop an understanding of the principles of jig and fixture design;	Emphasize that jigs and fixtures, components used in mass production tooling processes, allow for the production of duplicate parts, thereby increasing production rates. Explain the following features related to jig and fixture design: • workpieces can be clamped securely; • jigs and fixtures can be securely affixed to tables so as not to move or vibrate during machining operations; • jigs and fixtures can be easily removed from machines;	Jigs and Fixture Design, Delmar Publishers

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	. machining operations can be accurately performed; . chips from drilling or cutting can be easily removed; . dimensions can be located at the same end of the part for accuracy.	
2. design jigs for metalwork products;	Emphasize that the design of a jig and a fixture is very similar and that design depends on dimensional accuracy, type of material, and number of parts to be machined. Make students aware that industrial jigs and fixtures are designed by tool designers and constructed by tool and die makers.	
3. build jigs for metal work products;	Discuss and demonstrate the steps in designing and building jigs to perform operations on metal parts, emphasizing these points: a) Jigs should be safe and easy to operate. b) Anyone should be able to use the jig to perform accurate machining operations. c) Chips should be easily removed. Have students follow these procedures for designing and building jigs for metalwork projects in the classroom:	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	a) Analyze the drawing for the required machining operations. b) Sketch the part showing the location of operations; i.e., drilling, cutting, etc. c) Add locating pins to the sketch. d) Locate clamping devices on the sketch. e) Design the body or base of the jig. f) Add dimensions to the sketch. g) Build the jig, and then test it.	
4. design fixtures for metalwork products;	Make students aware that the steps for designing and building jigs can be applied to designing and building fixtures.	
5. build fixtures for metalwork products;	Demonstrate the procedures for designing and building fixtures and have students follow these. Emphasize the importance of testing jigs and fixtures to make sure that they adhere to the principles of design and function properly. Ask students to make the requisite changes in the design and construction of their jigs and fixtures, and have them assess the need for this refining process.	
6. use jigs and fixtures to manufacture metalwork products.	Have students use their finished jigs and fixtures to manufacture metalwork products.	

XIV. MASS PRODUCTION (C.)

Estimated Time: 10-15 hours

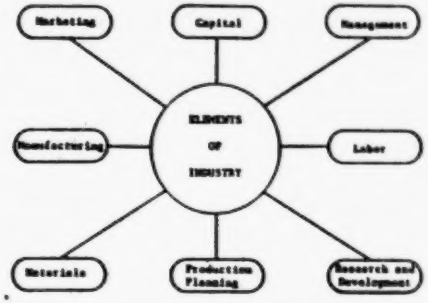
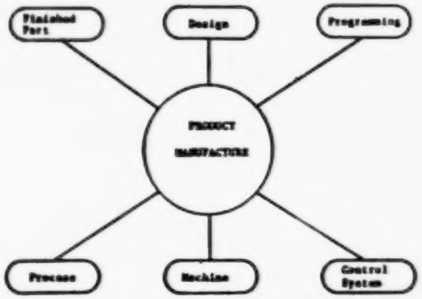
MAJOR OBJECTIVE: To gain an understanding of the principles and influence of mass production; to explain the essential elements of industry; to describe the basic steps in manufacturing product parts and in planning a manufacturing system of mass production; and to apply the principles and procedures to mass production of products/projects.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
A. INTRODUCTION TO MASS PRODUCTION The student should be able to:		
1. develop an understanding of the manufacturing process of mass production;	Point out that because human needs and wants have increased continually over time, techniques and procedures leading to mass production have been developed to produce large quantities of items quickly and inexpensively. Have students participate in discussion and prepare reports and displays to increase their understanding of these points: a) Mass production makes items available in large quantities. b) Companies produce several models of a product with only slight changes. c) Parts for products are standardized so that many fit into different models of the same product.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Have students define mass production.	MASS PRODUCTION: A system to make standardized or interchangeable parts, which divides labour among many people
2. identify the principles of mass production;	Make students aware of the principles of mass production developed by Eli Whitney and Henry Ford. To aid students in developing an awareness of the principles of mass production, have them participate in activities like these: . discussing each of the principles; . assessing the applicability of the principles in today's industry; . visiting a manufacturing plant to see how the principles are applied; . viewing films on manufacturing to identify the principles; . discussing the influence of computer technology, robotics, and manufacturing in space on the principles. (Ask students to consider these questions: should some of the principles be deleted? Should principles be added?) . determining how many principles are applicable to mass production in the school laboratory; . preparing short reports on the history of mass production.	WHITNEY'S PRINCIPLES OF MASS PRODUCTION 1. Each machine can be set up to do a specific machine operation on many parts 2. Parts can be assembled quickly into the finished product 3. Parts can be machined accurately 4. The system requires less skill on the part of workers 5. Much time is saved in the production of parts 6. Each part accurately reproduces similar parts and can be interchanged, thus reducing assembly costs 7. The system reduces costs and increases efficiency 8. Tooling-up requires time and risk on the part of the manufacturer FORD'S PRINCIPLES OF MASS PRODUCTION 1. Accurate duplication of parts makes interchangeable parts possible 2. Each worker has a specific job to perform 3. Wasted motion and wasted time are eliminated

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
		4. Conveyers bring parts and assemblies to and from workers 5. Tools, equipment, and workers are placed in order of operations needed for assembly 6. Travel distances for parts and subassemblies are kept as short as possible
3. describe the influence of mass production.	Have students discuss, add to, and prepare displays about these influences of mass production: . increase in industrial growth in Manitoba, Canada, the United States, and other countries; . decrease in production costs; . changes in lifestyles: mass consumption (many people buying and using various products), division of labour system in the workplace, and increased leisure time. Ask students to identify, discuss and debate the positive and negative influences of mass production.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
B. INDUSTRY AND MASS PRODUCTION		
The student should be able to:		
1. describe the essentials of industry;	Use discussion and audio-visual materials and have students prepare displays and reports to increase their understanding of these essentials of industry: . material resources--raw materials such as metals, plastics, and wood from which people make things; . capital resources--money, factories, and the machines and tools used to acquire and work on raw materials; . human resources--people and the many things they are able to do.	1. Material resources 2. Capital resources 3. Human resources Manufacturing: A Basic Text for Industrial Arts, McKnight Publishing, Chapter 2
2. state the purpose of each element of industry;	Have students study the following diagram as a basis for discussion and research leading to reports and displays on the purposes of each of the elements of industry.	Introduction to Manufacturing, Delmar Publishing, Unit 1 Manufacturing: Industry and Careers, Prentice-Hall, Unit 4 The World of Manufacturing, McKnight Publishing

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	 Marketing Capital Management Manufacturing ELEMENTS OF INDUSTRY Labor Materials Production Planning Research and Development	Manufacturing: Industry and Careers, Prentice-Hall Basic Manufacturing Processes, McGraw-Hill Ryerson Manufacturing: Material Processing, Management, Careers, Goodheart-Willcox
3. explain the basic steps followed by manufacturers of product parts;	Emphasize that processes in the manufacturing of product parts vary according to the shapes, kind, and use of each part. Have students study this diagram to acquaint them with the basic steps in product manufacturing:  Finished Part Design Programming PRODUCT MANUFACTURE Process Machine Control System Manufacturers of product parts follow these basic steps. Have students apply these steps to mass production of products/parts in the school laboratory.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
4. describe the basic steps requisite for planning a manufacturing system for mass production.	Emphasize that an important challenge in manufacturing is to plan a system to produce the required number of products in the shortest amount of time, and that planning, basic to manufacturing, is a prerequisite to mass production. Have students participate in various teaching/learning activities related to each of the basic steps requisite for planning a system for mass production. Have students discuss, read, research, and view audio-visual aids to increase their understanding of the significance of these basic steps:	BASIC STEPS FOR PLANNING A MANUFACTURING SYSTEM FOR MASS PRODUCTION 1. Identifying consumer demand 2. Designing and engineering products 3. Planning production 4. Tooling-up for production 5. Planning quality control
	a) Identifying consumer demand--Point out that manufacturing companies must find out what people want to ensure that products will sell. Have students think about these questions: What products do people want? How many of them do they want? How does a manufacturing company obtain answers to the foregoing questions?	Manufacturing: A Basic Text for Industrial Arts, McKnight Publishing, Chapter 9
	b) Designing and engineering products--Emphasize that apart from considering how well a product will work, small details must also be considered (for example, how it will look--its shape, size, colour). Indicate that in industry designing and engineering can require many years before an acceptable product is developed.	Product Design, Obtaining Managerial Approval for Developing Products, Tooling Design, Quality Control, Developing Production Methods, What's in a Name, Developing a Marketing System, Packaging, Manufacturing: An Integral Part of Society (colour filmstrips, cassettes, printed copies of scripts), Ball State University

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	c) Planning production--Point out that planning for production can take a long time, since details must be determined before production starts. Encourage students to consider these questions: How many parts will be made? How many parts will be purchased? What machines will be used? How many people will be needed and what will each person do? How long will each process take?	
	d) Tooling-up for production--Emphasize that tools and machines must be in the right locations, special jigs and fixtures may be necessary for use with machines, and some machines may need to be built. Ask students to discuss the importance of a trial run before moving to final production.	Introduction to Manufacturing and Management, Research and Development, Production, Marketing, Industrial Relations, Financial Affairs, Labour Unions (transparency masters), Ball State University
	e) Planning quality control--Make students aware that quality of a product is determined by how well it is designed and made. Have them think about this question: What would happen if a company had no plan for checking the quality of its products?	
C. PRODUCT PRODUCTION The student should be able to:		
1. produce products by applying the	Have students work in groups to select products for mass production. Encourage them	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
principles and procedures of mass production.	to use many of the principles of mass production, the elements of industry, and the basic steps requisite to planning a manufacturing system for mass production in the industrial arts laboratory. Have students develop and follow plans for each of the following aspects of mass production: a) Identification of a product--Select a product which can be mass produced in the industrial arts laboratory. b) Design of a product--Discuss function, materials, appearance, fabrication, time, and cost. Review and apply the principles of design. c) Engineering of a product--Prepare detail and assembly drawings, construct a prototype, and design and construct jigs and fixtures. d) Control of production--Plan layout of the industrial arts laboratory for mass production, develop production flow charts, select materials, tools, machines, and equipment, assign tasks, use trial run to analyze flow of work and operation of production line, and then produce the product. Emphasize that the success or failure of a manufacturing company/project depends on how well the production of a product has been planned.	

XV. ENTERPRISE SYSTEM (C.)

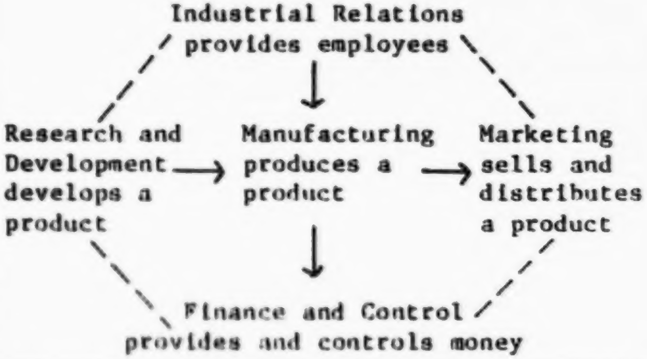
Estimated Time: 10-15 hours

MAJOR OBJECTIVE: To develop an understanding of the enterprise system, the various business organizations and their importance to industrial production, the divisions of an industrial organization, the role of management in corporations, and the way corporations are established.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Refer to Module XV, Enterprise System, in Manufacturing area of study.	Industrial Arts 7-9: Manufacturing (Manufacturing), Module XV, Enterprise System
A. INTRODUCTION TO ENTERPRISE SYSTEM The student should be able to:		
1. explain enterprise system;	Have students discuss and define enterprise system. Point out that Canada's economic system is a mixture of private and public enterprise. Explain that private enterprise is the sector of the economy owned by private individuals or groups; public enterprise, the sector owned by government. Have students list private and public enterprises in the local community, in Manitoba, and in Canada.	ENTERPRISE SYSTEM: An economic system related to business ownership
2. develop an understanding of the various systems of business organization;	Emphasize that the size of the business determines, to a considerable extent, the way the business is organized, and that a business or company can be owned by different numbers of individuals in accordance with various ownership systems.	PROPRIETORSHIP: A system of ownership where one person owns and operates the company

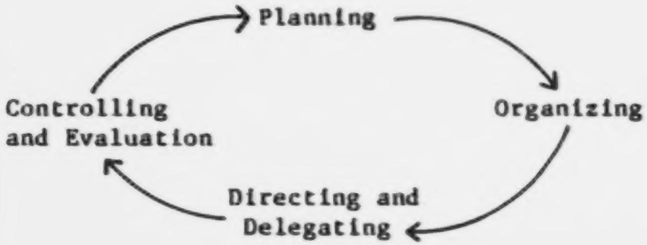
TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Have students define these various systems of business ownership: proprietorship, partnership, corporation, cooperative, and crown corporation. Have students identify local, Manitoba, and Canadian companies under each system of ownership.	**PARTNERSHIP**: A system of ownership where two or more owners are each responsible for the operation of the company **CORPORATION**: A business organization in which shareholders own the company and an elected board of directors is responsible for the operation of the company **COOPERATIVE**: A business organization owned by its customers **CROWN CORPORATION**: A business organization in which all people in a country or a province own a portion of the company
3. describe the advantages and disadvantages of each type of business organization.	Have students work in groups to prepare charts and reports on the advantages and disadvantages of proprietorship, partnership, corporation, cooperative, and crown corporation.	
B. ORGANIZING FOR INDUSTRIAL PRODUCTION The student should be able to:		
1. develop an understanding of the	Emphasize these concepts:	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
importance of organizing for industrial production;	a) Industrial production is usually organized on the basis of certain needs, such as the development of a new product, the selling of a product, the realizing of profits, and the production of more products. b) Industrial production meets the needs of consumers by providing necessary products and the needs of the company by making profits available.	Manufacturing: Industry and Careers, Prentice-Hall, Unit 3
2. identify the five divisions of an industrial organization;	Point out that most large organizations consist of five divisions and that the success of a company depends upon the operation of these five divisions.	FIVE DIVISIONS OF INDUSTRIAL ORGANIZATION 1. Research and Development 2. Manufacturing 3. Marketing 4. Industrial Relations 5. Finance and Control
3. explain the responsibilities of each of the five divisions of an industrial organization;	Have students research the responsibilities of each of the five divisions of an industrial organization, and then prepare posters and illustrated reports on the subject. Acquaint students with these responsibilities: a) Research and Development--working with ideas to create new products and developing knowledge about the material or processes used by the company.	Product Design, Obtaining Managerial Approval for Developing Products, Tooling Design, Quality Control, Developing Production Methods, What's In a Name, Developing a Marketing System, Packaging, Manufacturing: An Integral Part of Society (colour filmstrips, cassettes, printed copies of scripts), Ball State University

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	b) Manufacturing--setting up machines and obtaining all materials needed for production, planning, organizing, and controlling production, and maintaining production facilities. c) Marketing--selling the product, looking for new product ideas and new markets, planning for sales, and advertising and distributing the product. d) Industrial Relations--dealing with hiring, training, retraining, job satisfaction, and firing of employees. e) Finance and Control--obtaining and controlling money needed to operate the business, and purchasing all supplies and materials needed by the company.	
4. develop an understanding of the relationship of divisions within an industrial organization.	Have students study the following diagram to acquire an understanding of the way the five divisions are related.  Industrial Relations provides employees Research and Development develops a product Manufacturing produces a product Marketing sells and distributes a product Finance and Control provides and controls money	Introduction to Manufacturing and Management, Research and Development, Production, Marketing, Industrial Relations, Financial Affairs, Labour Unions (transparency masters), Ball State University

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Emphasize the direct relationship of research and development to manufacturing, and to marketing. Explain how finance and control and industrial relations provide support for all the activities of the company, that each of the divisions is necessary for the efficient operation of the whole, and that if one division fails to perform as planned, all others are affected.	
C. ORGANIZING A CORPORATION The student should be able to:		
1. develop an understanding of the importance of a corporation;	Review the definition and the advantages and disadvantages of a corporation. Point out that a corporation is probably the best type of business organization for an industrial arts class to form to manufacture products.	
2. explain the procedures for incorporating a company;	Discuss incorporation procedures, and show students audio-visuals about these. Acquaint students with these forms: articles of incorporation, certificate of incorporation, and bylaws of a corporation. Contact a Junior Achievement office to obtain information related to corporation procedures. Invite representatives of industry and government and lawyers to the	Articles of Incorporation Certificate of Incorporation Bylaws of a Corporation Introduction to Manufacturing, McKnight Publishing, Units 17, 18, 19, 20, 23

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	classroom to explain various aspects of incorporating and operating a business.	
3. organize an in-school company to manufacture a product;	Have students role play the steps to incorporate a company for the production of a product. Encourage students to use Junior Achievement or other information to establish a corporation to mass produce and distribute a product.	Exploring Metalworking Basic Fundamentals, Goodheart-Willcox, Unit 17
4. explain how a corporation acquires capital.	Discuss the financial needs of a corporation. Have students prepare reports on these methods of raising money: borrowing money, selling stocks, and reinvesting profits. Assist students with the preparation of estimates and budgets for all facets related to manufacturing a product.	Manufacturing: Industry and Careers, Prentice-Hall, Unit 3
D. ROLE OF MANAGEMENT The student should be able to:		
1. develop an understanding of the management process;	Emphasize that in any kind of business/corporation important decisions are made daily; for example, someone must decide how many goods are to be produced and how they are to be produced, what raw materials must be ordered, when, where, and how much to advertise, and who to hire.	Manufacturing: Industry and Careers, Prentice-Hall, Unit 2

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
2. define management;	Have students discuss and define management.	MANAGEMENT: The person or persons in a business who make major decisions and provide leadership
3. explain the components of the management cycle;	Have students study and discuss the diagram of the management cycle and define each of the management functions.  Planning Organizing Directing and Delegating Controlling and Evaluation MANAGEMENT CYCLE	PLANNING: The process of setting goals and developing a plan of action for reaching goals ORGANIZING: The assignment of people and facilities to accomplish goals DIRECTING: The process of telling and showing people how to do jobs CONTROLLING: The process of insuring that results are in line with company goals, plans, and objectives
4. describe the seven manufacturing M's;	Have students identify and describe the seven manufacturing M's. Point out that the success of a company/corporation depends on more than the components of management in the management cycle. Emphasize that a company/corporation depends upon people and things, and that people and things can be said to have seven basic needs/parts which must be met/obtained if the goals of management are to be achieved.	SEVEN BASIC M's OF A MANUFACTURING CORPORATION 1. Money 2. Machines 3. Material 4. Men and Women 5. Methods 6. Markets 7. Management Manufacturing: Industry and Careers, Prentice-Hall, Unit 2

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	During discussion emphasize how the seven M's are related internally and to the management cycle. Make students aware of these concepts: a) Money--Expenses of a company are usually divided into two major categories: working capital and fixed capital. Working capital is money used to purchase raw materials, pay worker salaries and taxes, and purchase miscellaneous company and employee needs. A company must either have an adequate supply of money or a close working relationship with financial institutions. Ask the students to answer these questions: How does a company obtain working capital? What does a company purchase with fixed capital? b) Machines--In more than ninety percent of the manufacturing companies, all parts for products are made by using various machines and tools which must be up-to-date if the products are to be competitive in quality and price. c) Material--Companies must have adequate supplies of all parts which make up the products. Ask students to identify the various kinds of metal, plastics, wood and other materials used in the manufacturing of products.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	d) Men and Women--Point out that industries need workers who are willing to produce quality products efficiently. Have students discuss this question: What is the relationship of automation, computers, and technology to the production of quality products? e) Methods--Discuss the use of numerically controlled and computer controllled machines and the importance of continuing to develop new and better methods for producing things and for using raw materials. f) Markets--Point out that markets include how and where a company sells its products. Ask the students to discuss this question: Why does a company sell its products? g) Management--Review the concept that management must plan, organize, direct and evaluate the tasks of a company. Discuss the relationship of money, machines, material, men and women, methods, and markets to management.	
5. use management functions.	Have students practice the management functions and apply the seven M's by developing management teams for manufacturing project products; have them list the roles and responsibilities of each member of the management team.	

plastics

CORE MODULES: Student Orientation, Safety, Careers, Measurement, Design and Construction, Consumerism, Materials, Separation, Forming, Fastening, Finishing, Jigs and Fixtures, Mass Production, Enterprise System

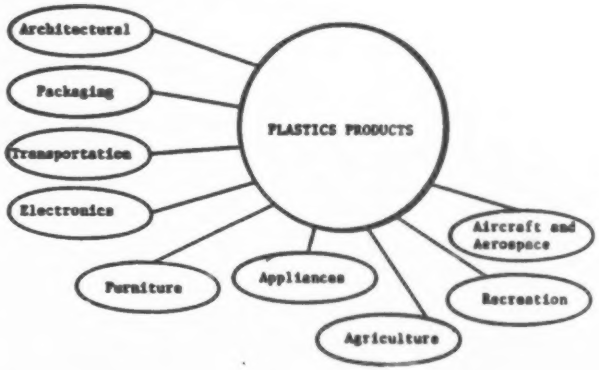
PLASTICS

I. STUDENT ORIENTATION (C.)

Estimated Time: 3 hours

MAJOR OBJECTIVE: To explore the relationship of industrial arts to the needs of individuals, industry, and society.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	NOTE: Refer to Common Modules for Module I, Student Orientation.	Industrial Arts 7-9: Manufacturing (Metalwork, Plastics, Woodwork, Manufacturing), Module I, Student Orientation
	Emphasize the relationship of plastics and plastic products to some of the basic needs in life, such as food, clothing, shelter, transportation, communication, and recreation. Point out that the modules in Plastics explain basic theory and that projects provide opportunities to explore and apply basic skills and principles and to acquire appreciation and knowledge of methods used in industry.	Industrial Plastics, Goodheart-Willcox, Chapter 1
	Involve students in "brainstorming" and research sessions to help them understand how plastics affect major industries, both as they compete with and supplement traditional materials and methods. Ask students to study this diagram and then to prepare illustrated charts, displays, and reports about various industries which provide major markets for plastic products.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	 PLASTICS PRODUCTS Architectural Packaging Transportation Electronics Furniture Appliances Agriculture Recreation Aircraft and Aerospace Encourage students to enhance their understanding of plastics by participating in individual and group activities like these: . preparing lists of plastic products and their uses in everyday life; . locating information from articles in newspapers and periodicals about plastic products being developed for the market; . preparing lists of plastic materials/parts used in automobiles, motorcycles, or other large products.	

II. SAFETY (C.)

Estimated Time: 4 hours

MAJOR OBJECTIVE: To develop safety consciousness in the use of tools, machines, and processes, through a wide range of experiences related to the individual and to the production and servicing aspects of hobbies and industries in plastics.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	NOTE: Refer to Common Modules for Module II, Safety. Emphasize the following: a) Students studying the basics of plastics must learn safety precautions. b) The right way of doing a job is the safe way. c) The use of safety precautions is protection against injury. d) Safety is a matter of common sense and good judgment. e) The application of safety precautions in all laboratory activities is essential to making them a part of regular work habits. Have students discuss, observe, and prepare posters for six major safety rules pertinent to working with plastics.	Industrial Arts 7-9: Manufacturing (Metalwork, Plastics, Woodwork, Manufacturing), Module II, Safety MAJOR SAFETY RULES 1. Always dress correctly for the job 2. Follow directions 3. Practice good shop housekeeping 4. Learn to use tools and machines correctly 5. Avoid "clowning" 6. Report EVERY accident

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Have students practice the following aspects of proper laboratory procedures: . learning rules of conduct; . identifying and recalling safety rules; . becoming acquainted with class organization.	

III. CAREERS (C.)

Estimated Time: 3 hours

MAJOR OBJECTIVE: To gain information about the general occupational characteristics of a variety of career fields and to match interests, abilities, likes, dislikes, and values to characteristics of various careers.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	NOTE: Refer to Common Modules for Module III, Careers. Integrate career instruction throughout this area of study by familiarizing students with many careers, thereby providing them with a basis on which to make career choices, and by encouraging self-evaluation in relation to career opportunities and future goals. Point out that knowledge of career opportunities in plastics will help students to determine future educational, vocational, and life skill endeavours. Create an awareness of occupational families related to Plastics. Prepare students for study in advanced vocational and technical programs in plastics by providing them with occupational information and exploratory experiences directly related to current practices in industry and by acquainting them with programs available in secondary schools, community colleges, and universities.	Industrial Arts 7-9: Manufacturing (Metalwork, Plastics, Woodwork, Manufacturing), Module III, Careers C - Concern, Cooperation, Choices, Competence A - Appearance, Attendance, Attitude R - Reading, 'Riting, 'Rithmetic, References E - Experience, Equality, Example E - Effective use of time R - Respect, Recognition S - Spirit Industrial Plastics, Goodheart-Willcox, Chapter 19 Exploring the World of Plastics, McKnight Publishing, Chapter 3 Manufacturing Processes: Plastics, Prentice-Hall, Unit 1 Industrial Arts Plastics, Chas. A. Bennett, Chapter 24

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Acquire various display materials for the laboratory or classroom that provide information about jobs related to plastics.	Plastics Technology, McGraw-Hill, Appendix A Career Awareness Resource Library (videorecordings), Library, Manitoba Deparment of Education The Machinist in the Plastics Molding Industry (kit), Library, Manitoba Department of Education
	Implement a procedure encouraging students to prepare files of personalized occupational information, including data on personal interests, aptitudes, and achievements.	Careers: An Overview, Prentice-Hall
	Emphasize the importance of being well informed about all aspects of a career, from educational requirements and employment opportunities to conditions in the work environment.	
	Make students aware that career decisions are influenced not only by an individual's interests and work values, but also by his or her attitude towards change, risk taking, and helping others.	
	Involve students in research activities to develop their awareness of careers in plastics. Point out that many communities employ people in these job categories:	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	a) Semi-skilled workers, helping skilled workers, operate machines and equipment, assemble manufactured parts into a final product, and inspect and test manufactured items to determine whether they operate satisfactorily. b) Skilled workers, having completed apprenticeship programs, perform the exacting work of the plastics trade, serving as mold builders, machine service workers, machine setup persons, and general machinists. c) Technicians, assisting engineers, test various experimental devices and machines, help compile statistics, cost estimates, and technical reports, program parts for production by numerically and robotically controlled machines, and repair and maintain these machines. d) Supervisors, dealing with production problems and personnel, are responsible for meeting production schedules, maintaining molding material inventories, checking and supervising machine operations, and meeting shipping schedules. e) Professional people, in teaching and engineering fields, are employed at various levels, such as chemical and mechanical engineers, research chemists, sales personnel, and educators.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Have students enhance their knowledge of careers in plastics by taking part in individual and group projects like these: · preparing lists, charts, and displays of occupations made possible directly or indirectly by the plastics industries; · researching and listing various plastics industries in the local community, in the province of Manitoba and in Canada; · preparing an illustrated report about a plastics industry, following an outline similar to this: history, products made, rate of growth, number of people employed, kinds of occupations and their educational and skill requirements, employee salaries and benefits; · looking through newspaper employment columns to list the opportunities available in plastics-related jobs; · viewing films and preparing displays about the influence of computer technology and robotics on occupations in plastics; · visiting open house day at a regional comprehensive secondary school.	

IV. MEASUREMENT (C.)

Estimated Time: 4 hours

MAJOR OBJECTIVE: To procure knowledge and skills related to imperial and SI metric systems of measurement and measuring devices and to apply the knowledge and skills to measurement activities and problems pertinent to work in plastics.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Integrate instruction, practice, and applications of measurement throughout each module in this area of study. Point out the need to follow safety precautions and procedures and to make accurate measurements.	
A. INTRODUCTION TO MEASUREMENT The student should be able to:		
1. define measurement;	Have students discuss and define measurement. (Have them include this definition, along with others made in this area of study, in their notebooks.) Emphasize that measurement communicates information about size, shape, distance, and weight, and have students give examples of these measurements in plastics. Make them aware that measurement is made by comparing an unknown quantity with a standard or known quantity.	MEASUREMENT: A method of communicating size, shape, distance, and weight

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
2. explain the importance of measurement;	Make students aware of the relationship between good workmanship and accurate measurements. Have them identify ways in which measurement applies to various aspects of work in plastics.	
3. recognize the need for standards;	Explain that standards for measuring in plastics, developed over the years, have been agreed upon by organizations such as ISO, ANSI, and CSA, with representation from many industries. Indicate that these standards, the same throughout the world, aid in communicating information pertinent to measurement for plastics.	ISO: International Organization for Standardization ANSI: American National Standards Institute CSA: Canadian Standards Association
	Inform students that published standards define measurement of length, volume, area, weight, time, temperature, and other values.	Standard Measurement (colour 16 mm film), Library, Manitoba Department of Education
4. identify the basic types of quantity measurement;	Identify and discuss the basic kinds of quantity measurement. Have students prepare charts, posters, displays, and/or reports about the basic types of quantity measurement.	BASIC TYPES OF QUANTITY MEASUREMENT 1. Length 2. Mass 3. Time 4. Temperature 5. Electric current 6. Amount of substance 7. Light intensity

TOPICS AND OBJECTIVES

5. list and give application examples of SI metric and imperial units of measurement used in plastics.

SUGGESTED ACTIVITIES AND NOTES

Have students identify SI metric and imperial units of measurement used in various plastics activities. Have them prepare charts for their notebooks or for the classroom identifying SI metric and imperial units of measurement and their applications in the plastics industry. Emphasize the following:

UNITS OF MEASURE

QUANTITIES	SI METRIC UNITS	IMPERIAL UNITS	APPLICATIONS
Length, distance	metre	yard foot, inch	Linear measurements Thickness, width, and length of plastics material
	millimetre	foot, inch	Length and width of plastics products and buildings Layout work and measurements in respect to constructing parts of plastics products
Area	square millimetre, square centimentre, square metre	square inch, square foot, square yard	Area of parts of plastics products and plastics buildings
Volume	cubic millimetre, cubic centimetre, cubic metre	cubic inch, cubic foot, cubic yard	Volumes of various types of plastics stock
Mass/ Weight	kilogram	pound	Quantity unit of plastics stock
Temperature	degrees Celsius	degrees Fahrenheit	Heat treating of plastics
Pressure	KPa MPa	p.s.i.	Pressure and stress related to plastics

RESOURCES

Industrial Plastics, Goodheart-Willcox, Reference Section, p. 290

Metric Measurement I: Measurement and Why We Need a Standard Measurement, Metric Measurement II: What Is the Metric System and How Is It Used, Metric System (16 mm colour film), Library, Manitoba Department of Education

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
B. MEASURING DEVICES The student should be able to:		
1. identify common measuring tools;	Acquaint students with common measuring tools. Point out that tools measure and mark plastics stock. Have students identify the tools by preparing labelled charts, posters, or displays of them.	COMMON MEASURING TOOLS 1. Rules 2. Flexible tapes 3. Dividers 4. Scribers 5. Squares 6. Temperature and press gauges
2. use common measuring tools;	Demonstrate working with common measuring tools, and allow students to explore their use. Emphasize safety and discuss the relation between corect use and maintenance of tools to resultant products and projects. Demonstrate measuring thickness, length, and width of film and sheet stock and of rod, tube, profile, fibre, and filament stock. Have students perform similar measurement activities. Demonstrate measuring liquid plastics and plastics powders, pellets, and granules, Have students perform similar activities.	 Industrial Arts Plastics, Chas. A. Bennett, Chapter 3

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
3. recognize the need for precision measuring instruments in plastics;	Point out that accurate measurement is essential to safe mass production of interchangeable plastic parts by discussing the following: a) Every part must be accurately made to the size and shape specified. b) Parts made inaccurately do not fit other parts of the product. c) Inaccurate measurement can result in finished products malfunctioning or wearing out sooner than they should. d) Parts manufactured in one location are often fitted to a final product assembled in another location. e) The safety of individuals can depend on accurate measurements in the manufacture of such items as bicycles, motorcycles, automobiles, tractors, combines, aeroplanes, and space vehicles. Emphasize that precision measurement is part of life today. Ask students to illustrate this concept by way of posters, displays, reports, and demonstrations.	
4. identify precision measurement instruments;	Show students precision measurement instruments (or illustrations of these). Discuss the influence of technology on precision measurement (e.g., electronic micrometer).	PRECISION MEASUREMENT INSTRUMENTS 1. Calipers 2. Micrometers

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Have students use different sizes of cardboard mailing tubes to make a large working model of the hub and thimble of a micrometer.	Measuring Instruments (16 mm colour film), Library, Manitoba Department of Education
5. use precision measurement instruments.	Demonstrate and then have students use the correct procedures for measuring with precision instruments available in the laboratory. Explain that these instruments must be well maintained if they are to function accurately. Provide students with diagrams of various micrometer settings and ask them to record readings. Prepare a transparency, complete with several overlays, to teach beginning students to read micrometers or other precision measurement instruments, especially those applicable to plastics.	

V. DESIGN AND CONSTRUCTION (C.)

Estimated Time: 5-8 hours

MAJOR OBJECTIVE: To obtain knowledge and skills related to the principles of planning and design and to apply the knowledge and skills to plan, design, and construct plastics projects and products.

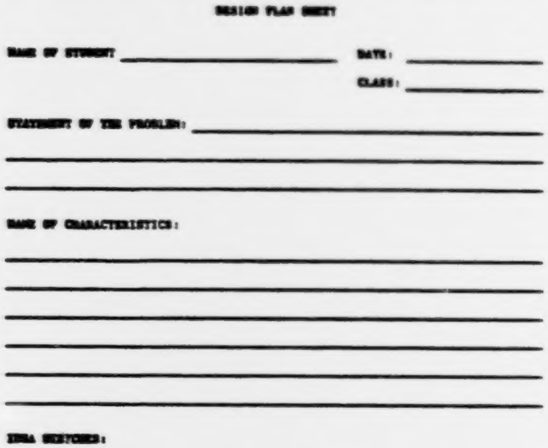
TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Integrate instruction in planning and design throughout all modules in this area of study.	
A. PLANNING FOR PLASTICS The student should be able to:		
1. define planning;	Have students discuss and define planning. Point out that plastics products/projects must be planned before being manufactured. Make students aware that planning involves two important resources, people and things, to meet human needs.	General Plastics Projects and Procedures, McKnight Publishing Company, Chapter 4 PLANNING: The process of identifying and considering details before manufacturing begins
2. develop an understanding of the importance of planning;	Point out, citing examples, that planning for various products/projects begins some time before actual work starts.	
3. identify the components of planning.	Emphasize that planning for plastics products is a cooperative process, requiring many people to use resources, equipment, and tools effectively to meet the needs of society, business, industry, and individuals. Discuss and define the components	COMPONENTS OF PLANNING 1. Formulating 2. Researching 3. Designing 4. Engineering

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	of planning. Make students aware of the relationship of long- and short-term planning.	FORMULATING: The process of deciding what to manufacture to meet needs RESEARCHING: The process of gathering facts to assist with decision-making DESIGNING: The process of developing a plan to meet needs
	Emphasize the importance of scheduling and coordinating for the completion of projects and products in plastics. Point out that improper planning can waste motion, materials, and effort, and result in higher costs.	ENGINEERING: The process of adding details to a design and of scheduling manufacturing
B. DESIGNING FOR PLASTICS The student should be able to:		
1. recognize the importance of design;	Review the definition of designing. Point out that designing involves creative and original planning, rather than copying, to meet societal, industrial, business, and human needs. Encourage students to enhance their knowledge of design in plastics by studying catalogues, magazines, and newspapers and by visiting stores and craft shops.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
2. identify the requirements for design;	Emphasize that good design in plastics responds to these requirements: strength, function, appearance, materials, cost, and quality.	DESIGN REQUIREMENTS 1. Strength 2. Function 3. Appearance 4. Materials 5. Cost 6. Quality
3. explain the relationship of design to strength, function, appearance, materials, cost, and quality;	Discuss the influence of design requirements on the design process, and have students consider the following questions: a) Strength—Will the design result in a strong and durable product? b) Function—Does the design fit the purpose for which it was planned? c) Appearance--Do the parts appear to belong together and is the product pleasant to look at, to live with, and to use? d) Materials—Have the materials been used effectively? e) Cost--Does the cost relate to strength, function, appearance, materials, and quality of the finished product? f) Quality--Is quality an inherent part of the finished product? Indicate that these interrelated requirements are common to all good designs.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
4. describe the basic design elements;	Identify and then have students define each of the design elements. Point out the relationship of basic elements to design requirements and principles.	LINE: Establishes expression, leads the eye in particular directions, outlines surfaces and contours of form SHAPE: Determines whether an object is pleasing to look at or touch relies on line, colour, and surface texture SPACE: Volume, including openings which an object occupies COLOUR: Creates effects such as warmth, coldness, distance TEXTURE: Indicates the surface condition, can be felt and seen, and can be related to the pattern
5. explain the principles of design;	Provide students with information about these principles of design: balance, proportion, rhythm, harmony, unity, emphasis, and variety. Make them aware that the principles can be used to organize the elements of a product so that it is pleasing to view. Have students collect illustrations and models of various types and styles of plastics products. Ask them to examine and assess the illustrations and models by answering these questions about the application of the design principles: a) Balance--Do the parts seem to have the same value? Are the parts on each side	PRINCIPLES OF DESIGN 1. Balance 2. Proportion 3. Rhythm 4. Harmony 5. Unity 6. Emphasis 7. Variety

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	of the centre line alike in size and shape? b) Proportion--Does the size of one part of a product relate to another part? How does the function or use of an object control its proportion? c) Rhythm--Are the elements or features such as lines, curves, forms, colours, and textures repeated? Do they give the object a pleasing appearance? d) Harmony and Unity--Do the parts of an object appear to belong together? e) Emphasis--Does the design have a point of interest? f) Variety--Are different materials, shapes, and colours used to give an interesting and lively appearance to the product?	
6. identify steps in the design process.	Provide students with information about steps pertinent to the design process, especially those that apply to the development of projects/products in plastics. Encourage students to think of projects/products as design problems and to use planning sheets in giving consideration to these requests:	STEPS IN DESIGN PROCESS 1. Statement of the problem 2. Analysis and research 3. Possible solutions 4. Experimentation 5. Final solution

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	 DESIGN PLAN SHEET NAME OF STUDENT: ____ DATE: ____ CLASS: ____ STATEMENT OF THE PROBLEM: ____ NAME OF CHARACTERISTICS: IDEA SKETCHES: a) Statement of the Problem--What is the purpose of the project/product and how will it be used? b) Analysis and Research--Think through the problem. What must the project do? What are the needs or characteristics? What are some of the limitations to be considered? How have others solved similar problems? c) Possible Solutions--Develop ideas. What types of charts, sketches, and related labels and notes are necessary to portray the ideas and to determine the required materials? Is it necessary to improve the sketches and notes to make a better design? d) Experimentation--Prepare several models of mockups of the design from paper,	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES

cardboard, soft wire, styrofoam, plasticene, or other easily manipulated material. What methods of joining and forming materials should be used? What new materials could be used to improve the design? In what ways should the design be changed or improved?

e) Final Solution--Develop working drawings and a worksheet related to the solution and construct the project/product. How should the drawings be used during the construction process? What parts are required? In what order should the operations be completed?

WORKSHEET

STUDENT ______________________ **DATE** ______________________

PROBLEM ______________________ **CLASS** ______________________

A. LIST OF PARTS

#	PART NAME	MATERIAL SIZES			MATERIAL	#REQ'D	COST
		L	W	T			
1							
2							
3							
4							
5							
6							
7							
						TOTAL	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES

B. **ORDER OF OPERATIONS**

STEP	OPERATION	MACHINE OR TOOL REQ'D
1		
2		
3		
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Have students present their models to the class to obtain suggestions for improvements.

Encourage students to compile notebook records of their own ideas and of ideas collected from periodicals, newspapers, and reference books for projects/products. Have them study publications on design to acquire more information about the relationship between projects/products and design. Make them aware that skill and knowledge acquired through experience are needed to solve design problems.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
C. PROJECT CONSTRUCTION The student should be able to:		
1. develop an understanding of the importance of sketches, working drawings, and stretchouts/patterns;	Show students examples of sketches, working drawings, and stretchouts/patterns, and explain their importance. Emphasize that sketches are diagrams portraying views and possible shapes and sizes of a product/project. Explain that working drawings, giving all the information needed to make the product, must show the following items: shape of every part, size of every part, kind of material, type of finish, and number of pieces in each part. Point out that a stretchout/pattern is a full-size drawing of the product/project on a single plane. Show the students examples of stretchouts/patterns of prisms, cylinders, and cones. Show them various products (or illustrations of products) made in shapes such as letter trays, rectangular and square boxes, rectangular planters, fishing tackle boxes, lunch boxes, juice and vegetable containers, cylindrical pencil holders and planters, tumblers, pails, and funnels.	General Plastics Projects and Procedures, McKnight Publishing, Chapters 4-5
2. interpret sketches, working drawings, and stretchouts/patterns;	Explain how to extract information from sketches, working drawings, and stretchouts/patterns, and provide students with opportunities to read and interpret these.	Basic Blueprint Reading and Sketching, Delmar Publishers

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
3. prepare sketches, working drawings, and stretchouts/patterns;	Acquaint students with diagrams, especially working drawings and stretchouts/patterns, drawn with certain kinds of lines, signs, and abbreviations. Demonstrate the procedures for preparing sketches, working drawings, and stretchouts/patterns for plastics products/projects, and have students follow these procedures.	
4. construt and evaluate products/projects.	Have students use the information prepared on design plan sheets, worksheets, sketches, working drawings, and stretchouts/patterns to construct products/projects. Encourage them to assess the construction process, including the use of tools, and the completed products/projects on the bases of planning and design principles and by comparing the input of materials, labour, energy, and other resources to the quality of workmanship and the time and money expended.	

VI. CONSUMERISM (C.)

Estimated Time: 3 hours

MAJOR OBJECTIVE: To explore the economic system and the economy in relation to plastics and consumer awareness.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Integrate instruction in consumerism and applications of consumerism to business and individuals throughout each module in this area of study.	
A. ECONOMIC SYSTEMS AND PLASTICS The student should be able to:		
1. define economic system;	Explain the term economic system, emphasizing that it refers to the following: a) The way individual workers and managers, productive organizations such as factories or farms, and government agencies are linked together to form a system, a unit, or an organization. b) The way decisions are made as to what workers, productive organizations, and government agencies will do to solve the basic economic problems each nation, province, and local community faces.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Discuss the basic economic questions, pointing out their relation to plastics businesses, services, and products and to consumers of these services and products. Make students aware that political, social, religious, and moral systems influence economic systems, and change from one country to another and within single countries over periods of time. Point out that by using and consuming resources, various economic systems produce plastics goods and services for consumers to purchase. Explain that the following economic activities provide resources for plastics goods and services: mining, manufacturing, agriculture, and construction. Point out that many plastics are wholly or partly made from petroleum or natural gas products or by-products. Have students research and report on the interrelationship of the petroleum and plastics industries. Point out that individuals and businesses should select goods and services wisely and effectively during the production of plastics goods and services.	BASIC ECONOMIC QUESTIONS 1. What to produce? 2. How to produce it? 3. Who will receive the services and finished products? 4. How much to produce over a period of time?
2. explain the basic parts of economic systems;	Discuss the basics required by economic systems to produce goods and services: inputs, processes, and outputs. Make stu-	BASIC PARTS OF ECONOMIC SYSTEMS 1. Inputs

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	dents aware of the relationship of these parts to plastics businesses, services, and products, emphasizing the following: a) Inputs are resources required for work activities to produce goods and services. b) Processes are work activities required to produce goods and services. c) Outputs are goods and services produced by an economic system. Have students give examples of inputs, processes, and outputs for work activities related to plastics manufacture, services, and products.	2. Processes 3. Outputs
3. identify basic types of inputs.	Review the definition of inputs. Discuss the basic types of inputs, emphasizing that they are common to various organizations, such as schools, families, clubs, and businesses. Discuss the relationship among the basic inputs and their application to the production of goods and services for consumption by businesses, organizations, and individuals.	BASIC TYPES OF INPUTS 1. People 2. Knowledge and skills 3. Industrial resources 4. Utilities 5. Finance

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
B. PLASTICS AND CONSUMERISM The student should be able to:		
1. identify human needs;	Make students aware of the importance of the following human needs: physical, societal, intellectual, and emotional. Relate Maslow's hierarchy of human needs to the services and products of plastics. Encourage students to identify basic physical, societal, intellectual, and emotional needs. Point out the relationship between these needs and plastics work activities, services, and products.	Looking at the Consumer, Gage Publishing The Confident Consumer, Goodheart-Willcox MASLOW'S HIERARCHY OF HUMAN NEEDS 1. Physical needs 2. Security 3. Love and acceptance 4. Esteem 5. Self-actualization
2. explain how plastics meet human needs;	Emphasize that plastics and related services and products are available in different societal and economic systems. Have students prepare charts, bulletin board displays, or illustrated reports explaining the need of society, businesses, and individuals for different types of plastics products and services. Ask students to explain how the services and products provided by plastics help society and individuals to meet these basic needs: shelter, food, water, and clothing.	Charts Bulletin board displays

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
3. recognize the relationship between plastics and the economy.	Discuss the importance of various industrial and business activities to national, provincial, regional, and local levels of the economy. Have students investigate the effects of industrial and business activities on employment and businesses related to plastics. Make students aware that industries, businesses, and individuals use the services and products of plastics to produce other services and goods for consumption by various sectors of the economy.	
C. PLASTICS AND THE MARKETPLACE		
	Point out why prospective users of the services and products of plastics should develop an understanding of the marketplace and its relationship to the economy.	
The student should be able to:		
1. differentiate between needs and wants;	Have students compile lists of plastics services and products desired by individuals and have them recognize the difference between needs and wants. Make students aware of businesses that need and want services and products of plastics.	The World of Business: A Canadian Profile, Wiley Publishers, Chapter 18 NEEDS: Things required for basic life and survival WANTS: Things desired for pleasure and comfort

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
2. recognize the concept of quality versus cost;	Discuss the following concepts: quality versus cost, cost versus application, influence of demand on supply and cost, the state of the economy, financing, and advertising. Relate these concepts to the users and producers of plastics services and products.	
3. explain the role of supply and demand;	Point out the relationship of these concepts to the following aspects of plastics services and products: . planning and design; . human needs; . availability and use of resources; . employment; . availability and choice of the various services and products. Ask students to list things they would look for in buying specific plastics products. Have them visit local stores and report on various grades and prices of plastics articles. Show students two plastics products which look alike. Have them examine the products carefully to emphasize the importance of judging the value of products before buying them.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
4. describe the effects of inflation;	Explain the major causes and effects of inflation. Make students aware of the effect of inflation on individuals, industries, and businesses, particularly on those industries and businesses related to plastics.	
5. identify the positive and negative aspects of credit buying;	Discuss the advantages and disadvantages and the direct and indirect costs of credit to individuals and businesses. Have students compare the costs of items, particularly plastics items, purchased on cash and credit terms by individuals and businesses.	Looking at the Consumer, Gage Publishing, Chapter 3
6. explain the influence of advertising;	Define advertising. Discuss the influence of advertising on various plastics products and services. Have students collect information and examples related to advertising for displays and reports. Point out the relationship of advertising to cost, supply and demand, and needs and wants pertinent to plastics products. Discuss advertising psychology and propaganda and point out that attempts can be made to persuade people to buy, regardless of need, or ability to pay. Encourage students to study advertisements/sales promotions carefully to sift out propaganda and false advertising from honest sales efforts.	TYPES OF ADVERTISING MEDIA 1. Direct mail 2. Computers 3. Newspapers 4. Periodicals 5. Radio 6. Signs 7. Television

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
7. recognize the relationship of sources of materials to services and products of plastics;	Discuss the relationship of sources of materials to the services and products of plastics and to the industrial, business, and individual consumers of these services and products. Ask students to identify various sources of materials pertinent to plastics products. Have students, individually or in groups, prepare charts, scrapbooks, or illustrated reports on the development of plastics products from various sources.	
8. explain the consequences pertinent to the consumption of plastics products;	Have students identify the uses of plastics products in homes, farms, business and industry, communication, transportation, science, and medicine. Have them discuss the need for continued research related to sources of materials for plastics.	
9. justify the need for conservation and cost consideration of materials.	Have students develop and demonstrate, through research and projects, an understanding of the importance of conservation and cost consideration pertinent to the consumption of materials by industry, business, and individuals. Ask students to consider the relationship of recycling materials to work in plastics. Have them apply conservation and cost of materials to plastics services and products.	Exploring the World of Plastics, McKnight Publishing, Part 6

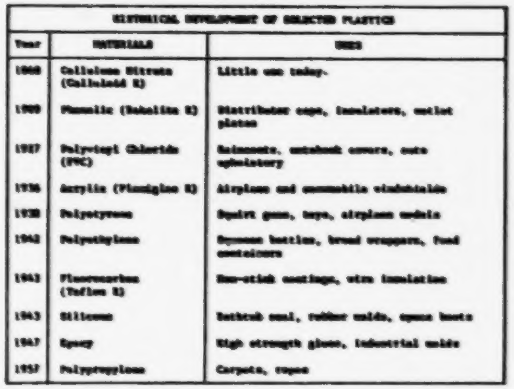
VII. MATERIALS (C.)

Estimated Time: 4-6 hours

MAJOR OBJECTIVE: To acquire information about the nature, source, classification, processing, and properties of plastics, and to apply this information to plastics projects and products.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Integrate instruction related to materials throughout other modules in the plastics area of study. Emphasize the relationship of materials to safety, measurement, consumerism and conservation, design and construction, forming, fastening, finishing, jigs and fixtures, and mass production.	
A. **INTRODUCTION TO PLASTICS MATERIALS** The student should be able to:		
1. develop an awareness of the nature and sources of plastics;	Discuss the nature and source of plastics by emphasizing the following aspects: a) Plastics cannot be mined and do not grow. b) Plastics are derived from various types of raw materials. c) Plastics are synthetic or manufactured materials. d) Plastics are formed through chemistry by using ingredients such as coal, water, air, petroleum, limestone, salt,	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	and agricultural by-products in different combinations. (Have students identify some of the major Canadian and Manitoban locations of raw materials used in the production of plastics materials.) e) Each type of plastic has individual properties and is selected by industry on this basis. f) Plastics are not dependent upon any single element.	Prospects for Plastics (16 mm film), Shell Canada Limited
	Ask students to consider these questions: Are the raw materials used to produce plastics renewable? How will renewability and non-renewability factors affect the plastics industry and research related to it?	
2. define plastics;	Have students discuss and define plastics. Emphasize that plastics become soft and moldable under heat and pressure, that they are then hardened or solidified into a molded shape, and that the name plastics has come to mean a moldable or formable synthetic material.	PLASTICS: Synthetic materials made up of chains of molecules
3. describe the historical development of plastics materials;	Have students collect newspaper clippings and research other sources for articles in order to prepare reports about the historical development of plastics materials. Encourage research on the work of these and other people in the plastics industry: John W. Hyatt and Dr. Leo H. Backeland.	Introduction to Plastics (colour filmstrip, cassette), Arnold-Nasco

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Make students aware of important events related to the development of plastics such as World War II, space exploration, and the energy crisis.	
4. recognize the importance of plastics.	Have students assess and prove this statement: "Plastics products are everywhere around us." Ask them to work on group projects, such as posters, displays, or illustrated booklets, to indicate the wide use of plastics in manufacturing various transportation vehicles, as well as various products for the home, school, office, and industry (such as television sets, computers, furniture, garden equipment, carpeting, sports equipment, artificial turf, and clothing).	Plastics in Art and Industry (16 mm film), Library, Manitoba Department of Education

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Encourage students to develop their knowledge of plastics by participating in activities like these:	
	. listing plastics products and their uses in everyday life;	*Manufacturing Processes: Plastics*, Prentice-Hall, Units 1-2
	. checking recent-model motorcycles, automobiles, household appliances, and agricultural implements and listing parts made of plastics;	*Basic Industrial Arts Plastics*, McKnight Publishing, Chapters 1, 2
	. identifying ways in which plastics are used in construction.	
B. *CLASSIFICATIONS OF PLASTICS* The student should be able to:		
1. identify the classifications of plastics according to physical properties;	Point out that for identification purposes plastics fall into these two main groups, according to physical properties: thermoplastics and thermoset plastics.	*Industrial Plastics*, Goodheart-Willcox, Chapters 1-3
2. compare the two main groups of plastics classified by physical properties;	Have students discuss, research, observe, and experiment with the differences between these two main groups of plastics:	*What Are Plastics?*, *Thermoplastic*, *Thermosetting*, *Raw Materials Used to Produce Synthetic Resins* (colour transparencies, overlays, instructor's guide), AIM Educational Aids

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	a) Thermoplastics: . can be reprocessed or reused; . can be melted or softened by heat; . can be molded or formed into a shape; . can retain new shapes when cooled; . can be heated and cooled many times; . can be granulated and molded again, if defective. b) Thermoset plastics; . cannot be reprocessed or reused; . cannot be softened by heat; . can harden in the mold while still hot because of chemical reaction; . can be softened only once. Compare heating and cooling of thermoplastics to heating and cooling of butter or wax, and heating and cooling of thermoset plastics to heating and cooling of eggs.	Thermoplastics (16 mm film), Library, Manitoba Department of Education General Plastics Projects and Procedures, McKnight Publishing, pp. 19-32
3. classify plastics as thermoplastic or thermoset;	Have students collect various plastics pieces and use a soldering iron on each to determine which are thermoplastics and which are thermoset plastics. Acquaint students with names of thermoplastics and thermoset plastics, and have them prepare charts and displays indicating the characteristics and uses of each.	TYPES OF THERMOPLASTICS 1. Acetals 2. Acrylics 3. Cellulosics 4. Ethyl-vinyl-acetate 5. Fluorocarbons 6. Ionomer 7. Nylon

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
		8. Phenoxy 9. Polphenylene oxide 10. Polycarbonates 11. Polyethylene 12. Polyolefins 13. Polypropylene 14. Polysulphone 15. Polystyrene 16. Polyurethane 17. Vinyls TYPES OF THERMOSET PLASTICS 1. Alkyds 2. Allylic 3. Aminos 4. Epoxies 5. Phenolics 6. Polyesters 7. Silicones
4. identify classifications of plastics according to chemical sources.	Point out that plastics may be classified according to their chemical sources by emphasizing the following classifications: a) Cellulosis plastics are made by treating wood linters or wood pulp with acids. b) Synthetic resins include all plastics except cellulosics and protein plastics. c) Protein plastics are made from soy beans, milk, peanuts, cashews, and other agricultural products.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	d) Cold-molded plastics are molded first without heat removed from molds, and baked in order to oxidize and polymerize the binder materials. e) Inorganic plastics are glass-bonded mica, compounded from natural mica and low-melting glass; ceramoplastics are made from synthetic mica and high-melting glass. f) Alloy plastics are made by blending two different plastics or by combining plastics with other types of materials.	The World of Acrylics (kit), Library, Manitoba Department of Education
C. PROCESSING PLASTICS The student should be able to: 1. explain the basic process of making plastics material;	Acquaint students with these principles related to the basic process of making plastics material: a) Monomer is the beginning point of all plastics. b) Monomer means one part and mer refers to one repeating structural unit. c) Monomer, usually gas or liquid, is the material the chemist uses to begin building a plastics material. d) The monomer goes through a special chemical reaction called polymerization.	MONOMER: A simple compound which can react to form a polymer OR Material made up of small molecules all of the same size Industrial Plastics, Goodheart-Willcox, Chapter 2 Exploring the World of Plastics, McKnight Publishing, Chapter 3

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	e) Polymerization begins with small simple molecules from nature and the monomer, and results in the simple molecules being rearranged to form giant molecules known as polymer. f) Many different arrangements of giant molecules result in many different plastics materials. g) Adding or subtracting an atom of another element or a molecule produces a variety of polymers. h) Addition polymerization results in thermoplastic materials. i) Compensation polymerization results in thermosetting materials. Have students build ball and stick models (styrofoam balls and toothpicks) depicting monomer and polymer molecules.	Raw Materials Used to Produce Synthetic Resins, Synthetic Resins, Homopolymerization, Copolymerization, Molecular Structure of Plastics (colour transparencies, overlays, instructor's guide), AIM Educational Aids POLYLMERIZATION: Chemical reaction in which molecules of a monomer are linked together to form large molecules POLYMER: The plastics molecule OR A giant or high molecular weight molecule composed of many monomers linked together
2. define standard stock;	Point out that plastics are produced in many shapes, sizes, and forms and that plastics wholesalers carry a stock of different types.	STANDARD STOCK: Common shapes, sizes, and forms in which plastics are manufactured, measured, and sold
3. identify the various forms of common plastics stock;	Discuss various forms of common plastics stock, and have students locate examples and illustrations of these. Have students indicate some of the uses of common plastics forms.	FORMS OF PLASTICS 1. Film and sheeting 2. Rods, tubes, profiles 3. Fibers and filaments

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
		4. Liquids and adhesives 5. Powders, pellets, and granules 6. Hollow beads Fibreglass (16 mm film), Library, Manitoba Department of Education Prospects for Plastics (16 mm film), Shell Film Library
4. explain the relationship of common forms to ordering plastics materials.	Have students refer to stock lists or to handbooks of materials from companies that manufacture plastics supplies. Encourage students to use these references when ordering plastics materials required for projects. Emphasize the need to describe each item accurately and clearly.	
D. PROPERTIES AND USES The student should be able to:		
1. explain the classifications of plastics properties;	Point out that properties of plastics determine the type best suited for a specific job. Explain the classifications of plastics properties by emphasizing these principles during discussion, demonstration, and/or experimentation: a) Mechanical properties indicate how plastics react to various forces, such	CLASSIFICATIONS OF PLASTICS PROPERTIES 1. Mechanical properties 2. Physical properties 3. Chemical properties 4. Thermal properties 5. Electrical properties 6. Optical properties

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	as tensile strength (pulling, stretching), compressive strength, and impact strength. b) Physical properties result from the internal structure of plastics. c) Chemical properties refer to the relationship of plastics to acids, alkalies, and solvents. d) Thermal properties indicate the ability of plastics to conduct heat. e) Electrical properties relate to the dielectric strength, the insulating value of plastics against the flow of electricity. f) Optical properties indicate how plastics transmit light and ultraviolet and infrared rays.	Exploring the World of Plastics, McKnight Publishing, Chapter 1 Basic Industrial Arts Plastics, McKnight Publishing, Chapter 1 Manufacturing Processes: Plastics, Prentice-Hall, Unit 2
2. describe the various properties of plastics;	Discuss the importance of understanding the various properties of plastics and have students list and explain the properties. Discuss these concepts: a) Plastics have numerous outstanding properties or qualities. b) The properties/qualities vary greatly from family to family of plastics. c) A family of plastics is a group which is chemically the same. Have students study or prepare charts on how properties vary between plastics families, using these comparative terms: very low, low, medium, high, very high.	VARIOUS PROPERTIES OF PLASTICS 1. Hardness and softness 2. Impact strength 3. Electrical insulation 4. Weight 5. Heat insulation 6. Temperature resistance 7. Friction 8. Elasticity 9. Transparency 10. Cushioning 11. Colour 12. Thickness

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
3. perform comparative tests to determine various properties of plastics;	Demonstrate and discuss comparative tests like these: heat specific gravity, flame, physical, and solvent tests. Emphasize requisite safety precautions and procedures. Have students perform simple comparative tests and record results in an identification chart similar to the following:	

IDENTIFICATION CHART

PLASTIC	SPECIFIC GRAVITY	HEAT TEST	BURN TEST (flame, smell, smoke, sound, colour)	PHYSICAL TEST	SOLVENT TEST
Styrene	Sinks?	[illegible]	Orange flame, black smoke, smell like marigold	Rather brittle	Toluene
Acrylic			Yellow flame, fruity or floral smell	Stiff, hard	
ABS					
Nylon			Blue flame, singed hair, burning vegetation		
Phenolic					
Polyethylene					
Polyvinylchloride			Plasticized—yellow flame; Rigid—difficult to burn, gas goes out when flame is removed		

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<tr><th>TOPICS AND OBJECTIVES</th><th>SUGGESTED ACTIVITIES AND NOTES</th><th>RESOURCES</th></tr>
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<td>4. identify recycled plastics products and their properties;</td>
<td>Have students suggest possible uses of recycled plastics products and recycle plastics products to produce new products. Ask students to identify the properties and prepare displays of the recycled plastics products.
<table>
<tr><th colspan="3">RECYCLED PLASTICS PRODUCTS AND PROPERTIES</th></tr>
<tr><td>Bleach Bottle</td><td>Funnel</td><td>Chemically inert, low temperature flexibility, good impact strength</td></tr>
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<tr><td></td><td></td><td></td></tr>
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</td>
<td>Recycled plastics products</td>
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TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
5. select plastics for various products according to properties;	Have students identify products made from plastics. Ask them to state reasons, based on properties, why different plastics have been used in the different products. Have them choose plastics for their projects/products, justifying their selections. Point out that selecting proper materials for projects/products, and giving reasons for the selection, are very important functions in industry.	
6. combine other materials with plastics.	Ask students to examine plastics products and to list the other materials included in the products. Emphasize that the inclusion of other materials adds variety to the product's appearance and design. Encourage students to do research and experiments related to combining new materials in plastics products, and to relate the principles of planning and design to the foregoing activities.	

VIII. SEPARATION (C.)

Estimated Time: 6-9 hours

MAJOR OBJECTIVE: To obtain knowledge and skills related to the separation processes and to the use, care, and maintenance of hand and power tools applicable to these processes in plastics.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Integrate instruction of separation throughout other modules in the plastics area of study. Make students aware of the relationship of separation to safety, measurement, materials, conservation of materials, and planning and design of products.	
A. METHODS OF SEPARATING PLASTICS The student should be able to:		
1. define separating;	Emphasize that during the process of building/manufacturing plastics products or components, the plastics materials must be stretched.	SEPARATING: Shaping material by removing portions of it
2. identify methods of separating plastics materials;	Hold a "brainstorming" session in which students can identify the various methods of separating plastics materials. Emphasize that separating methods are secondary processes often required after the primary processes of injection, compression, extrusion, and others.	METHODS OF SEPARATING 1. Shearing . Induced fracturing 3. Chip-forming 4. Thermal cutting Exploring the World of Plastics, McKnight Publishing, pp. 284-290

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
		Industrial Plastics, Goodheart-Willcox, pp. 245-248 Basic Industrial Arts Plastics, McKnight Publishing, PL72-PL-74 Manufacturing Processes: Plastics, Prentice-Hall, pp. 31-37 General Plastics Projects and Procedures, McKnight Publishing, Chatpers 7-9
3. describe the methods of separating plastics materials.	Discuss basic principles related to the separation processes by emphasizing the following: a) Plastics materials can be cut to desired shapes. b) Holes may be cut into pieces of plastics materials. c) Unwanted plastics material can be removed from the surface of a piece of plastics material. d) Notches or pieces of plastics material can be cut from the ends or edges. Point out the importance of safety precautions and procedures pertinent to each of the separation processes.	SHEARING: A method of cutting without producing waste in the form of chips or meltings INDUCED FRACTURING: A method of breaking brittle materials along desired lines by flexing the material opposite from a scored line CHIP-FORMING: A cutting or separating process (such as sawing, routing, planing, drilling, filing, scraping, sanding, chiselling, gouging, and machining) during which plastics chips are removed THERMAL CUTTING: A process of causing plastics materials to separate by melting the plastics material along a separation line

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
B. HAND AND POWER TOOLS FOR SEPARATING The student should be able to:		
1. identify common hand tools for separation processes in plastics materials;	Show students examples or illustrations of hand tools used in the separation processes, and have them select hand tools used for each process.	COMMON HAND TOOLS FOR SEPARATION PROCESSES Shearing tools Snips Shears Paper cutters Chipping tools Saws--hack, coping Drills--hand Files--hand, flat mill, pillar, square, round, half round, three square Hand scrapers and knives Hand sanders
2. perform the separation processes with hand tools with an increasing degree of accuracy;	Emphasize the relationship between correct use, care, and maintenance of hand tools, and accuracy in the production and performance of top-quality work pertinent to the separation processes. Give frequent performance tests covering the tools used in the separating processes.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
3. identify common power tools for the separation processes for plastics materials;	Show students examples or illustrations of common power tools for separating processes. Have them identify each tool by name. Give them the names of the separating processes and have them list or select the power tools used for each. Use visual and audio-visual aids to introduce power tools not available in the laboratory. Have students prepare illustrated research reports on new developments in machining tools.	POWER TOOLS FOR SEPARATION PROCESSES Shearing tools Shears--bench, power, squaring Hot and cold dies Chipping tools Saws--hack, band, circular, jig Drills--portable electric, drill press Files--filing machines Sanders--disc, belt Metal or wood lathes Thermal cutting tools Hot wire cutters
4. use power tools applicable to separation processes;	Demonstrate procedures for the accurate use of power tools applicable to separation processes. Provide students with opportunities to practice separation processes using available tools and scrap materials. Emphasize the safe use and the care and maintenance of power tools. Discuss and demonstrate safety checks for various types of power tools. Make students aware of the advantages and disadvantages of power tools.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
5. perform the separation processes with power tools with an increasing degree of accuracy.	Emphasize the relationship between the correct use, care, and maintenance of power tools and the accuracy in the production and performance of top-quality work pertinent to the separation processes. Give frequent performance tests on the power tools available in the laboratory.	

IX. FORMING (C.)

Estimated Time: 6-9 hours

MAJOR OBJECTIVE: To gain knowledge and skills related to forming and to the use, care, and maintenance of tools and equipment applicable to various forming processes in plastics.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Integrate instruction in forming throughout modules in the plastics area of study. Make students aware of the relationship of forming to safety, measurement, consumerism, materials, design and construction of products, fastening techniques, and mass production.	
A. METHODS OF FORMING PLASTICS The student should be able to:		
1. define forming;	Discuss and demonstrate the need for shaping plastics materials by forming processes during the manufacture of plastics products. Have students discuss and define forming.	FORMING: Rearranging plastics materials to different shapes without the loss or addition of material
2. identify common industrial methods for forming plastics materials.	Point out that for plastics and plastics products to be useful to individuals and industries, they must have certain shapes and sizes. Have students develop an understanding of common industrial methods for forming plastics materials by participating in activities like these:	PLASTICS PRODUCTS FORMED BY INDUSTRIAL METHODS Method Product Molding: -injection model car kits

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<tr><th>TOPICS AND OBJECTIVES</th><th>SUGGESTED ACTIVITIES AND NOTES</th><th>RESOURCES</th></tr>
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- researching reference sources;
- preparing illustrated written reports, oral presentations, charts, or displays on various common industrial forming methods;
- viewing films and other audio-visuals;
- visiting plastics industries;
- collecting plastics products and preparing classroom displays identifying methods used to form each product;
- preparing a list of plastics products in the home and school, and identifying the forming methods used.
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<td>
<table>
<tr><th>Method</th><th>Product</th></tr>
<tr><td>-extrusion</td><td>Vinyl trim</td></tr>
<tr><td>-blow molding</td><td>Containers, bottles</td></tr>
<tr><td>-compression</td><td>Melmac dishes</td></tr>
<tr><td>-transfer</td><td>Counter tops</td></tr>
<tr><td>Forming:
-thermoforming</td><td>"Bubble" van windows</td></tr>
<tr><td>Filament winding</td><td>Fishing rods
Manitoba Hydro snorkel</td></tr>
<tr><td>Foam molding</td><td>Plaques, frames</td></tr>
<tr><td>Powder molding</td><td>Plastics tool grips</td></tr>
<tr><td>Casting</td><td>Desk sets</td></tr>
<tr><td>Calendering</td><td>Upholstery material</td></tr>
</table>
Exploring the World of Plastics, McKnight Publishing, Chapters 4-13
Industrial Plastics, Goodheart-Willcox, Chapters 5-16
General Plastics Projects and Procedures, McKnight Publishing, Chapters 19, 20, 25, 27, 35
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</table>

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
		Basic Industrial Arts Plastics, McKnight Publishing, Chapters 2-4 Manufacturing Processes: Plastics, Prentice-Hall, Units 4, 6, 7
B. FORMING METHODS IN INDUSTRIAL ARTS LABORATORY The student should be able to:		
1. recognize the forming methods used in the industrial arts laboratory;	Discuss and demonstrate the various forming methods applicable to the industrial arts laboratory. Show students samples of products formed by each of the laboratory methods.	FORMING METHODS IN THE INDUSTRIAL ARTS LABORATORY 1. Injection molding 2. Rotational molding 3. Casting 4. Thermoforming -vacuum -drape -blow -pressure 5. Bead expanding 6. Thermofusing 7. Laminating
2. explain the various forming methods used in the industrial arts laboratory;	Have students prepare reports, charts, and definitions for the various laboratory forming methods.	INJECTION MOLDING: A method by which heat-softened plastics material is forced from a cylinder into a relatively cool cavity of desired shape

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Emphasize that in rotational molding a heated hollow mold is charged with a measured amount of plastisol and rotated in one or two planes. The hot mold fuses the plastisol into a homogeneous layer on the inner mold wall which is then chilled and the product is stripped out.	ROTATIONAL MOLDING: A method used to make hollow articles from plastisols CASTING: A method used to make an article by pouring fluid plastics material into a mold and allowing it to set up
	Acquaint students with these thermoforming categories: vacuum, drape, blow, and pressure.	TERMOFORMING: A method used to form a thermoplastic sheet by heating the sheet and pulling it down onto a mold surface or by blowing air under the sheet
	Point out that expandable polystyrene bead foams are thermoplastics in the shape of small spheres with sponge-like centres. Emphasize that when they are heated, their cell walls soften and the gas inside expands, causing the softened beads to expand and fuse together in a mold.	BEAD EXPANDING: A method used to expand and mold polystyrene bead foam THERMOFUSION: A method used to fuse/melt plastics together in or on a mold surface
	Point out that during the thermofusion process only gravity and atmospheric pressure are used, that the plastic materials used in the process may be either dry powder or liquid, and that there are two main types of thermofusion: static and dynamic.	LAMINATING: A method by which layers of plastics materials are formed under pressure into sheets or parts
3. identify the common plastics materials used in common laboratory processes;	Acquaint students with the relationship between the common plastics materials and the forming processes used in the industrial arts laboratory by having them study and discuss the following table:	Casting and Encapsulating, Reinforced Plastics, Thermoforming, Low and High Pressure Laminating (slides, cassettes), Copp-Clark Pitman

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES

C O M M O N L A B O R A T O R Y M E T H O D S

COMMON PLASTICS MATERIALS						
	POLYSTYRENE	POLYESTER	POLYETHYLENE	A.B.S.	VINYL	ACRLIC
INJECTION MOLDING	X		X	X		
ROTATIONAL MOLDING			X		X	
CASTING		X				X
THERMO-FORMING	X		X			X
BEAD EXPANDING	X					
THERMO-FUSION		X		X		
LAMINATING	X					

Casting Plastics (colour filmstrip, cassette), Arnold-Nasco

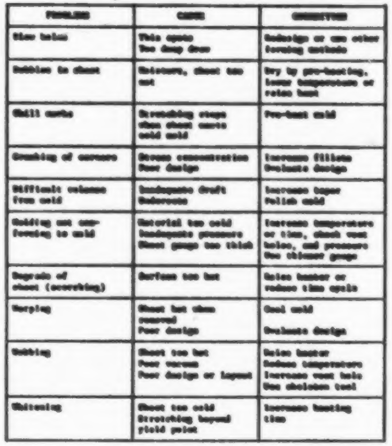
Extrusion, Laminating, Compression Molding, Transfer Molding, Casting, Blow Molding, Thermoforming, Rotational Molding, Expandable Bead Foam Molding, Reinforced Plastic Molding (colour transparencies, overlays, instructor's guide), AIM Educational Aids

4. form plastics materials using various forming methods;

Acquaint students with the equipment and tools necessary for each forming method. Demonstrate and have students use each method to complete products and projects. Emphasize requisite safety precautions and procedures.

FORMING PROCESSES AND EQUIPMENT

Process	Equipment
Injection molding	Injection molder, molds
Rotational molding	Rotational molder, molds, gloves
Casting	Molds
Thermoforming:	
-vacuum	Vacuum former, molds
-drape	
-blow	
-pressure	Strip heater, gloves

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
		Process — **Equipment** Bead expanding — Thermolyne hot plate container, molds, gloves Thermofusion — Oven, molds, gloves Laminating — Vises, clamps *Casting and Encapsulating*, *Reinforced Plastics*, *Rotational Molding*, *Thermoforming*, *Low and High Pressure Laminating*, *Injection Molding*, *Foam Molding* (slides, cassettes), Copp Clark Pitman
5. identify causes and corrective methods for defective forming;	Encourage students to evaluate the forming methods used, to determine defects, and to identify causes and corrective methods related to defects. 	

X. FASTENING (C.) Estimated Time: 10-12 hours

MAJOR OBJECTIVE: To obtain knowledge and skills related to the methods, tools, equipment, and materials applicable to mechanical, adhesion, and cohesion fastening procedures in plastics.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Integrate instruction in fastening throughout the modules in this area of study. Point out the relationship of fastening to safety, measurement, consumerism, materials, design and construction, forming, finishing, and mass production.	
A. METHODS OF FASTENING PLASTICS The student should be able to:		
1. define fastening;	Have students discuss and define fastening.	FASTENING: The process of binding, connecting, securing, holding, attaching, and/or affixing one item to another
2. develop an understanding of the importance of fastening;	Use illustrations, samples, and demonstrations to discuss these concepts: a) Some plastics products may be made up of more than one part. b) The selection of the proper plastics fastening technique for a given plastics product is extremely important.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	c) The time required to assemble plastics parts is affected by the fastening method. d) The cost of the assembled plastics product is influenced by the technique used. e) The final strength and safety of a plastics product is directly related to the way its parts are fastened together. f) A plastics product can be unsafe or unworkable if the wrong fastening technique is used. g) Fastening is one facet of the assembling process of plastics products. h) Technology, including robotics, is related to the fastening of plastics.	
3. identify the methods of fastening.	Emphasize that methods of fastening and types of fasteners have been influenced by needs of people at a particular time in history and by technological developments. Have students work in groups to trace the development of fastening methods.	Separating, Finishing, and Combining (colour filmstrip, cassette), Career Aids
	Acquaint students with these fastening methods used on plastics products: mechanical, adhesion, and cohesion. Ask them to define each method.	MECHANICAL FASTENING: Joining of two or more plastics pieces with the aid of screws, bolts, rivets, staples, and pins ADHESION FASTENING: Joining accomplished by the use of a substance, applied as an intermediate, to hold materials together by surface attachment

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
		OR Joining of two similar or dissimilar materials with another material called an adhesive COHESION FASTENING: Joining of two or more plastics pieces by cohesive cementing and sealing OR The process of fusing two similar materials together by means of heat or chemical action
B. MECHANICAL FASTENING The student should be able to:		
1. identify methods of mechanical fastening;	Review the definition of mechanical fastening. Discuss and have students locate examples and illustrations of these types of mechanical fastening used in plastics products: add-on fasteners and built-in fasteners.	
2. describe the purpose of add-on mechanical fasteners;	Point out that add-on mechanical fasteners, designated as extrinsic fasteners, are devices used on the outside of a product to hold the parts together.	Manufacturing Processes: Plastics, Prentice-Hall, pp. 48-49

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Emphasize and discuss these reasons for using add-on/extrinsic fasteners: a) The product can be taken apart for repairs and reassembled without damaging any of the parts. b) The add-on parts can be used to make fine adjustments. c) The add-on parts can exert force through movement.	Industrial Plastics, Goodheart-Willcox, pp. 254-256 General Plastics Projects and Procedures, McKnight Publishing, Chapter 17 Exploring the World of Plastics, McKnight Publishing, Chapter 14 Basic Industrial Arts Plastics, McKnight Publishing, PL77
3. recognize the various types of add-on/extrinsic fasteners;	Point out that add-on/extrinsic fasteners are made in many shapes and sizes, from different kinds of materials, and with various types of finishes. Acquaint students with the common add-on/extrinsic fasteners and have them participate in these teaching-learning activities: . preparation of labelled panel displays of add-on/extrinsic fasteners; . preparation of reports on the uses of add-on/extrinsic fasteners; . preparation of research projects on how add-on/extrinsic fasteners are manufactured; . participation in identification tests.	COMMON ADD-ON/EXTRINSIC FASTENERS 1. Screws 2. Speed nuts 3. Spring clips 4. Hinges 5. Rivets 6. Staples
4. use add-on/extrinsic fasteners;	Acquaint students with tools necessary for add-on/extrinsic fasteners. Point out the need to match tools to fasteners and to	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	match fasteners to plastics materials. Demonstrate and have students follow the procedures for fastening various plastics materials with proper add-on/extrinsic fasteners. Have them compare the various procedures. Emphasize safety precautions.	
5. recognize the various types of built-in/intrinsic fasteners;	Acquaint students with the various types of built-in/intrinsic fasteners and have them participate in activities like these: . preparation of labelled panel displays of built-in/intrinsic fasteners; . preparation of reports, oral presentations; and "show and tell" sessions on the uses of the various types of built-in/intrinsic fasteners; . participation in identification tests.	BUILT-IN/INTRINSIC FASTENERS 1. Snap fit 2. Press fit 3. Heat staking 4. Ultrasonic staking General Plastics Projects and Procedures, McKnight Publishing, Chapter 18 Exploring the World of Plastics, McKnight Publishing, Chapter 14 Basic Industrial Arts Plastics, McKnight Publishing, PL77-78
6. use built-in/intrinsic fasteners.	Demonstrate the techniques for using tools related to intrinsic fasteners. Demonstrate and have students use the procedures for fastening plastics products with built-in/intrinsic fasteners. Emphasize safety precautions and procedures.	

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TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
C. ADHESION FASTENING The student should be able to:		
1. identify methods of adhesion fastening;	Review the definition of adhesion fastening. Acquaint students with this method of adhesion fastening: adhesive bonding/cementing. Emphasize these concepts during class discussions: a) Adhesion is the joining of two plastic materials with a gluelike adhesive. b) Adhesive cementing is similar to the process of gluing wood. c) A film of the adhesive stays between the two materials and holds them together. d) Two materials which are unlike can be joined with adhesives if the adhesives can stick to both materials.	Industrial Plastics, Goodheart-Willcox, pp. 231-232 Exploring the World of Plastics, McKnight Publishing, Chapter 14 General Plastics Projects and Procedures, McKnight Publishing, Chapter 15 Basic Industrial Arts Plastics, McKnight Publishing, PL 76-77 Manufacturing Processes: Plastics, Prentice-Hall, pp. 47-48
2. explain the relationship of adhesion fastening to platics;	Have students discuss and prepare research reports and oral presentations about the relationship of adhesive fastening to plastics. Discuss these principles pertinent to the adhesive bonding of plastics materials: a) Adhesives can be used to bond thermoplastics or thermosets. b) Thermosets can be bonded with adhesives as well as with mechanical	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	fasteners. Ask students to think about this question: Why are there only two methods for fastening thermoset plastics? c) There must be an attraction between the adhesive molecules and the molecules of the plastics being bonded. Why? d) The right adhesive must be selected for the specific material. Why? e) Adhesives can be used to fabricate complex shapes because they do not mar the surface, are lighter, and will give under flexing.	
3. compare thermoplastic and thermoset adhesives;	Ask students to prepare charts, displays, and reports to emphasize these comparative aspects of thermoplastic and thermoset adhesives: a) Thermoplastic Adhesives: . are incapable of taking high temperatures or heavy loads; . include cellulosic plastics used in model cement; . include polyvinyl acetate (a white glue) used in woodworking; . include polyethylene used in many instances as a hot-melt adhesive. b) Thermoset Adhesives: . have more strength than thermoplastic adhesives;	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	. are not affected by high temperatures; . are more difficult to use as they require accurate measurement and thorough mixing; . cannot bond polyethylene, polypropylene, or teflon; . include urea and resorcinal used for wood; . include epoxy, a strong adhesive to bond almost everything except wood; . include silicone, a flexible adhesive and sealant.	
4. identify the types of adhesive fastenings;	Discuss and have students identify the components and uses of the three main types of adhesive fastenings.	MAIN TYPES OF ADHESIVE FASTENINGS 1. Bodied adhesives 2. Elastomeric adhesives 3. Reactive adhesives
5. join plastics materials by the adhesive bonding process.	Emphasize safety precautions requisite for various types of adhesives. Acquaint students with the tools and demonstrate the steps required to produce bonded joints. Have students use these steps as they apply to various kinds of adhesives to produce solid bonded joints in plastics products: a) Surface preparation--Emphasize that all adhesives require clean surfaces to produce full strength bonds. Ask students to explain the cleaning processes related to plastics materials.	STEPS TO PRODUCE SOLID BONDED JOINTS 1. Surface preparation 2. Adhesive preparation 3. Adhesive application 4. Assembly 5. Bond development

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	b) Adhesive preparation--Discuss setting up equipment, mixing procedures, and delivery of the adhesive to the work area. c) Adhesive application--Point out the proper ways to use brushes, rollers, sprays, dipping, and other methods. d) Assembly--Show how to position materials to be joined and how to use jigs to align materials. e) Bond development--Explain reasons for the curing of adhesives, the application of pressure, and other types of bond development. Ask students to test the strength of various adhesives and provide them with opportunities to use various adhesives in plastics products/projects.	
D. COHESION FASTENING The student should be able to:		
1. identify methods of cohesion fastening;	Review the definition of cohesion fastening. Acquaint students with the methods of cohesion fastening, using discussion and visual aids.	METHODS OF COHESION FASTENING 1. Cohesive cementing 2. Heat sealing 3. Thermal welding

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
2. develop an understanding of the importance of the various methods of cohesion fastening;	Emphasize these concepts related to the various methods of cohesion fastening: a) Cohesive cementing--The method of softening two plastic parts with solvents to cause the molecules in the two parts to mix together upon contact. Following the evaporation of the solvent, the plastic hardens and the two parts are joined as one. b) Heat sealing--Various heat sealing methods are used to fasten two thin pieces of thermoplastics film and sheet, using heat and pressure to melt two layers together to form a cohesive bond. c) Thermal welding--Various thermal welding processes are used to assemble thick and thin parts made of thermoplastics.	Industrial Plastics, Goodheart-Willcox, pp. 235-244 Exploring the World of Plastics, McKnight Publishing, pp. 303-315 Basic Industrial Arts Plastics, McKnight Publishing, PL78-79 Manufacturing Processes: Plastics, Prentice-Hall, pp. 40-47
3. describe the procedures for cohesive cementing;	Acquaint students with these two types of cohesive cements: solvent cements and monomeric cements.	
4. join plastics with cohesive cementing methods;	Discuss, demonstrate, and have students use the procedures for bonding acrylic parts, and ABS and PVC plastic pipes and fittings. Emphasize requisite safety precautions.	
5. recognize the various methods for heat sealing plastics;	Acquaint students with the various methods for heat sealing plastics by having them participate in activities like these:	METHODS FOR HEAT SEALING PLASTICS 1. Thermal sealing (fusion) 2. Impulse sealing (friction)

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	. preparing reports on thermal sealing, impulse sealing, dielectrical sealing, and ultrasonic sealing; . collecting plastics films that have been heat sealed and determining what method of heat sealing was used for each of the plastics; . visiting local industries that use heat sealing processes to fasten plastics; . researching literature to obtain information about each of the heat sealing processes.	3. Dielectrical sealing (hot seal) 4. Ultrasonic sealing (vibration)
6. fasten platics with heat sealing processes;	Demonstrate and have students follow the procedures for heat sealing processes and for using tools and equipment to fasten plastics. Have students participate in activities like these: . using a heat sealer to make a watertight packaging bag from plastic film; . setting up an experiment to impregnate the surface of a piece of cardboard with powdered polyethylene, and trying to heat seal a polyethylene skin package to the surface; . using a heat sealer (heated tool, impulse sealer, or ultrasonic sealer) to package molded parts, mass produced products, or gifts; . heat sealing a quantity of water into a bag.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
7. define welding;	Have students discuss, research, and define welding, a cohesion process for fastening plastics materials.	WELDING: Joining thermoplastic pieces by one of several heat-softening processes
8. describe the various platics welding methods;	Assist students to acquire information about hot gas welding, hot plate welding (fusion), spin welding (friction), and ultrasonic welding by having them visit local industries that make use of welding to fasten plastics materials. Invite professional welders to speak to the class and to demonstrate welding procedures related to plastics. Have students research information about each of the welding processes. Make them aware of the influence of technology on plastics welding methods.	
9. fasten plastics with welding processes.	Demonstrate and have students use procedures involving available laboratory equipment to fasten plastics with welding processes. Emphasize safety precautions. Encourage students to assess the quality of all their welding samples and projects.	

XI. FINISHING (C.) Estimated Time: 3-6 hours

MAJOR OBJECTIVE: To acquire information and skills related to a number of finishing processes in plastics and to perform these processes using tools and equipment with increasing accuracy.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Integrate instruction in finishing throughout other modules in this area of study. Emphasize the relationship of finishing to safety, careers, consumerism, design and construction, forming, fastening, and mass production.	
A. INTRODUCTION TO FINISHING The student should be able to:		
1. define finishing;	Have students discuss and define finishing.	FINISHING: Surface treatment of plastics done to improve the appearance, to protect the surface, and to make the product more functional
2. develop an understanding of the importance of finishing;	Discuss, using illustrations, samples, and audio-visuals, the following purposes of finishing plastics products: . to enhance the appearance of the product; . to improve resistance to wear; . to prevent scratching and marring;	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	. to change colour, texture, contrast, and design of the product; . to beautify the surface; . to provide identification and product information; . to counteract static.	
	Point out that most plastics products manufactured by modern industry require some kind of finishing.	
3. identify the categories of plastics finishes.	Emphasize that the categories of plastics finishes have evolved to meet the needs of industrial and technological processes, products, and developments.	
	Point out that all plastics finishing processes may be grouped into these major categories:	
	. adding material to plastics surface by combining processes; . removing material from plastics surface by separating processes; . giving some mechanical treatment to the plastics surface by forming processes.	FINISHING BY COMBINING: Adding materials, generally called finishes, to other materials to provide the desired colour or lasting qualities FINISHING BY SEPARATING: Obtaining a desired surface texture by removing material
	Show students examples of each category and ask them to look at plastics products used everyday to identify the many kinds of finishes, often two or more, used on a plastics product.	FINISHING BY FORMING: Obtaining a desired surface texture through pressure

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
		EMBEDDING: Enclosing objects closely in plastics OR Encasing articles in a closed envelope of plastics by immersing the objects in casting resin and allowing the resin to polymerize
B. ADDING MATERIALS TO PLASTICS SURFACE The student should be able to:		
1. identify the various types of surface coating;	Acquaint students with the types of surface coatings and have them prepare displays of each. Emphasize these types of coating materials: lacquers, enamels, paints, metals, plastics, and waxes.	SURFACE COATINGS 1. Lacquers 2. Enamels 3. Paints 4. Metals 5. Plastics 6. Waxes
2. develop an understanding of the purpose of each type of surface coating;	Have students discuss the purpose of each type of material used for coating surfaces of plastics. Have them research this topic in literature from the manufacturer.	Industrial Plastics, Goodheart-Willcox, Chatper 18 Exploring the World of Plastics, McKnight Publishing, Chapter 15

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
3. identify methods of adding materials to the surface of plastics;	Acquaint students with these methods of adding materials to the surface of plastics: silk screen decorating, waxing, painting, hot foil stamping, plating and vacuum metalizing, fluidized bed coating. Showing them examples of plastics products finished by adding materials to the surface. Acquaint them with various painting methods.	Basic Industrial Arts Plastics, McKnight Publishing, Chapter 5 Manufacturing Processes: Plastics, Prentice-Hall, Unit 7 PAINTING METHODS 1. Spray painting the entire surface 2. Mask spray painting 3. Flow coating 4. Dip coating 5. Roller coating 6. Spray and wipe painting
4. recognize the significance of surface preparation;	Emphasize that the surface of the plastics material must be clean for any finish to stick to it. Demonstrate the procedures for cleaning surfaces and give students opportunities to use these procedures.	
5. finish plastics products by adding material to the surface.	Familiarize students with the various techniques, tools, and equipment for applying lacquers, enamels, paints, metals, plastics, and waxes to plastics. Emphasize the steps for applying finishes, and the procedures for using and maintaining tools and equipment. Emphasize safety procedures and precautions. Provide students with opportunities to practice coating small samples of various types of plastics and encourage them to use	Coating and Laminating Plastics (colour filmstrip, cassette), Career Aids

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	the coating techniques to finish their plastics products/projects. Have students participate in activities like these: . performing hot stamping processes on plastics products made by thermoforming, injection, rotational, and blow molding; . setting up and hot stamping lettering or a design on several pieces of plastics; . making a display board that features products that have been hot stamped for decorative purposes; . setting up a silk screen for decorating thermoformed and blow-molded products; . using the roller coating method and experimenting with different types of paints to apply raised letters and designs on plastics products; . waxing and buffing plastics products; . preparing written reports on the most recent developments of plating plastics products; . securing samples and setting up classroom displays of electroplated plastics products; . building and using a fluidized bed coating machine to coat products.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
D. REMOVING MATERIAL FROM SURFACE		
The student should be able to:		
1. identify various methods of finishing by removing material from the surface;	Acquaint students with these separating finishing methods: trimming, filing, sanding, buffing, polishing.	
2. match the separating finishing methods to common plastics materials;	Have students study and discuss the chart on the page following which shows the relationship among common laboratory processes, common plastics materials, and methods of finishing.	
3. finish plastics products by using separating methods.	Acquaint students with the tools, equipment, and supplies for finishing plastics products by using separating methods. Demonstrate and have students follow these procedures. Emphasize safety precautions and procedures. Provide students with opportunities to become increasingly proficient in hand and machine separation finishing methods by allowing them to practice on small samples and to incorporate the processes into plastics products/projects.	TOOLS AND EQUIPMENT 1. Saws--hand, portable, power, and stationary 2. Files--smooth, second cut, bastard 3. Abrasives--coarse, medium, fire, paper, cloth, combination 4. Solvents--esters, ketones, hydrocarbon, alcohol 5. Cleaner--methylhydrate 6. Sanding machine--belt and disc 7. Buffing machine--tripoli wax Plastics, Goodheart-Willcox, Unit 2

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES

	COMMON PLASTICS MATERIALS						METHODS OF FINISHING					
COMMON LABORATORY PROCESSES	POLYSTYRENE	POLYESTER	POLYETHYLENE	A.B.S.	VINYL	ACRYLIC	TRIM	FILE	SAND	BUFF	POLISH	SOLVENT
INJECTION MOLDING	X		X	X			X	X	X			
ROTATIONAL MOLDING			X		X		X					
RESIN CASTING		X				X		X	X	X	X	
LAMINATING	X					X		X	X	X	X	X
BEAD EXPANDING	X											
THERMOFORMING	X		X			X	X					
THERMOFUSING			X powder		X vinyl plastisol							

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
D. MECHANICAL TREATMENT OF PLASTICS SURFACE		
The student should be able to:		
1. identify various mechanical methods of finishing surfaces of plastics products;	Show students examples of each of these mechanical treatment methods of finishing the surfaces of plastics products: embellishing surfaces by means of embossing and intaglio; inlaying, overlaying, and veining; and fluting.	General Plastics Projects and Procedures, McKnight Publishing, Chapters 21-13
2. finish plastics products with mechanical treatment methods.	Emphasize the requisite safety precautions and procedures related to each of the mechanical treatment methods. Acquaint students with the tools, equipment, and supplies necessary for each method. Demonstrate and have students use each of the finishing methods. Encourage them to incorporate these methods into plastics products/projects.	
E. ENGRAVING, CARVING, EMBEDDING		
The student should be able to:		
1. explain engraving, carving, and embedding;	Point out that plastics products lend themselves to a variety of decorative treatments and to the practical applications of engraving, carving, and embedding.	Industrial Plastics, Goodheart-Willcox, Chapter 18

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Show students examples of plastics products finished by engraving, carving, and embedding. Have them locate similar examples. Encourage students to enhance their knowledge of these methods through participating in activities like these, individually or in groups: preparing bulletin board and classroom displays, oral and written reports, visiting plastics industries, and viewing demonstrations and listening to talks by plastics craft workers. Emphasize that in engraving, the surface of the plastics material is cut with a sharp tool to produce letters and pictorial designs; in carving, designs are cut either on the surface or on the inside of clear plastic. Explain that embedding involves the complete enclosing of objects, such as stamps, coins, and biological specimens in plastics products.	Exploring the World of Plastics, McKnight Publishing, Chapter 15 Manufacturing Processes: Plastics, Prentice-Hall, Units 3, 7 General Plastics Projects and Procedures, McKnight Publishing, Chapters 25, 29
2. finish plastics products by engraving, carving, and embedding.	Emphasize the requisite safety precautions and procedures related to each of the processes. Acquaint students with the tools, equipment, and supplies necessary for each of the processes. Discuss care and maintenance of tools, equipment, and supplies.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Demonstrate and have students use each of the finishing methods. Have them participate in activities like these: . engraving name plates, signs, and room numbers in plastics products; . surface carving a design and/or preparing displays and reports on surface and inside carving; . embedding a coin or other object in a plastics product.	

XII. JIGS AND FIXTURES (C.) Estimated Time: 3 hours

MAJOR OBJECTIVE: To recognize the significance of jigs and fixtures, gaining knowledge and skills related to designing, constructing, testing, and refining jigs and fixtures for use in manufacturing plastics products.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	NOTE: Refer to Module XIII, Jigs and Fixtures, in the metalwork area of study.	Industrial Arts 7-9: Manufacturing (Metalwork), Module XIII, Jigs and Fixtures Industrial Arts Plastics, Chas. A. Bennett, Chapter 11 Jig and Fixture Design, Delmar Publishers

XIII. MASS PRODUCTION (C.) Estimated Time: 10-15 hours

MAJOR OBJECTIVE: To gain an understanding of the principles and influence of mass production; to explain the essential elements of industry; to describe the basic steps in manufacturing product parts and in planning a manufacturing system of mass production; and to apply the principles and procedures to mass production of products/projects.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	NOTE: Refer to Module XIV, Mass Production, in the metalwork area of study.	Industrial Arts 7-9: Manufacturing (Metalwork), Module XIV, Mass Production Exploring the World of Plastics, McKnight Publishing, Chapter 16

XIV. ENTERPRISE SYSTEM (C.) Estimated Time: 10-15 hours

MAJOR OBJECTIVE: To develop an understanding of the enterprise system, the various business organizations and their importance to industrial production, the divisions of an industrial organization, the role of management in corporations, and the way corporations are established.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	NOTE: Refer to Module XV, Enterprise System, in the metalwork area of study.	Industrial Arts 7-9: Manufacturing (Metalwork), Module XV, Enterprise System Exploring the World of Plastics, McKnight Publishing, Chapter 16

woodwork

CORE MODULES: Student Orientation, Safety, Careers, Measurement, Design and Construction, Consumerism, Materials, Separation, Forming, Fastening, Finishing, Jigs and Fixtures, Mass Production, Enterprise System

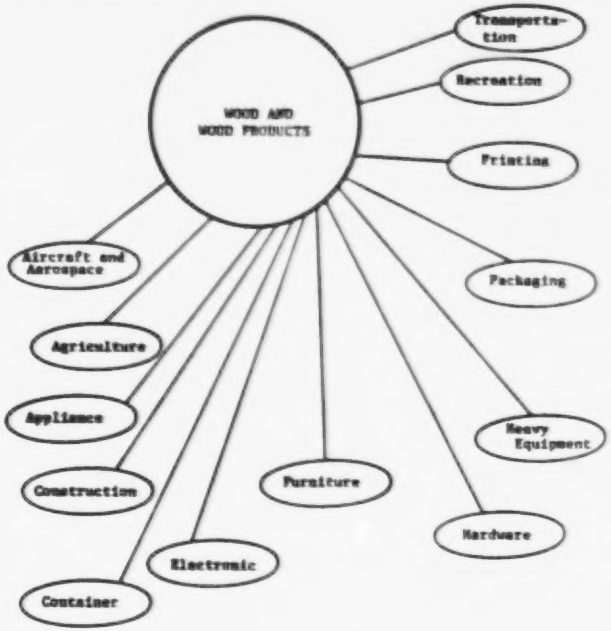
WOODWORK

I. STUDENT ORIENTATION (C.)

Estimated Time: 3 hours

MAJOR OBJECTIVE: To explore the relationship of industrial arts to the needs of individuals, industry, and society.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	NOTE: Refer to Common Modules for Module I, Student Orientation.	Industrial Arts 7-9: Manufacturing (Metalwork, Plastics, Woodwork, Manufacturing), Module I, Student Orientation
	Emphasize the relationship of woods and woodwork to some of the basic human needs, such as food, clothing, shelter, transportation, communication, and recreation. Point out that the modules in this area of study explain basic theory and that the projects provide students with opportunities to explore and apply basic skills and principles and to acquire knowledge of the methods used in industry.	The Basic Book of Woodworking, American Technical Society, Chapter 1 General Woodworking, Second Canadian Edition, SI metric, McGraw-Hill Ryerson, Unit 1 Woodworking Tools, Materials, Processes, American Technical Publishers, Unit 1
	Involve students in "brainstorming" and research sessions to help them understand how wood and wood products are used by people and industries.	Working with Wood, McKnight Publishing, Chapter 1
	Ask students to study this diagram and to prepare reports or displays about the various industries which use wood.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	 WOOD AND WOOD PRODUCTS Transportation Recreation Printing Packaging Heavy Equipment Hardware Furniture Electronic Container Construction Appliance Agriculture Aircraft and Aerospace Encourage students to enhance their understanding of wood and wood products by participating in individual and group learning activities like these: . listing various items made from wood and wood products and their everyday uses; . researching articles in newspapers and periodicals for information about wood products being developed for markets.	

II. SAFETY (C.)

Estimated Time: 4 hours

MAJOR OBJECTIVE: To develop safety consciousness in the use of tools, machines, and processes, through a wide range of experiences related to the individual and to the production and servicing aspects of hobbies and industries in woodwork.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	NOTE: Refer to Common Modules for Module II, Safety. Emphasize the following: a) Students studying the basics of woodwork must learn safety precautions. b) The right way to do a job is the safe way. c) Safety precautions are protection against injury. d) Safety is a matter of common sense and good judgment. e) Applying safety precautions in all laboratory activities is essential to making them a part of regular work habits. Discuss and have students prepare posters about six major safety rules to be observed during the study of woodwork.	Industrial Arts 7-9: Manufacturing (Metalwork, Plastics, Woodwork, Manufacturing), Module II, Safety The Basic Book of Woodworking, American Technical Society, Unit 2 Woodworking Tools, Materials, Processes, American Technical Publishers, Unit 6 General Woodworking, Second Canadian Edition, SI metric, McGraw-Hill Ryerson, Unit 10 Working with Wood, McKnight Publishing, Chapter 7 Hand Tool Safety, Machine Tool Safety (colour filmstrips, cassettes, program guide, reproducible masters), Prentice-Hall Media

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
		Introduction to Woodshop/Carpentry Safety, Hand Tool Safety, Power Equipment Safety (colour filmstrip, cassette), AIM Educational Aids Safety in the Wood Shop (series of transparencies and overlays), AIM Educational Aids Woodworking Shop Safety-Part II (filmstrip, cassette), School Services of Canada MAJOR SAFETY RULES 1. Always dress correctly 2. Follow directions 3. Practice good shop housekeeping 4. Learn to use tools and machines correctly 5. Avoid "clowning" 6. Report EVERY accident

III. CAREERS (C.)

Estimated Time: 3 hours

MAJOR OBJECTIVE: To gain information about the general occupational characteristics of a variety of career fields and to match interests, abilities, likes, dislikes, and values to characteristics of various careers.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	NOTE: Refer to Common Modules for Module III, Careers. Integrate career instruction throughout this area of study by familiarizing students with many careers, thereby offering them a basis on which to make choices, and by encouraging them to evaluate themselves in relation to various career opportunities and goals. Point out that a knowledge of career opportunities in metalwork will aid students in determining future educational, vocational, and life skill endeavours. Create an awareness of occuptional families related to woodwork. Prepare students for study in advanced vocational and technical programs in woodwork by providing them with occupational information and exploratory experiences directly related to current practices in	Industrial Arts 7-9: Manufacturing (Metalwork, Plastics, Woodwork, Manufacturing), Module III, Careers C - Concern, Cooperation, Choice, Competence A - Appearance, Attendance, Attitude R - Reading, 'Riting, 'Rithmetic, References E - Experience, Equality, Example E - Effective Use of Time R - Respect, Recognition S - Spirit General Woodworking, Second Canadian Edition, SI metric, McGraw-Hill Ryerson, Unit 4 Woodworking Tools, Materials, Processes, American Technical Publishers, Section 10 Basic Industrial Arts Woodworking, McKnight Publishing, Chapter 1

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	industry and by acquainting them with programs available in secondary schools, community colleges, and universities. Develop and acquire various display materials for the laboratory or classroom that provide information about occupations related to woodworking. Allow each student to prepare a file of personalized occupational information including data on personal interests, aptitudes, and achievements. Emphasize that students should be well informed about all aspects of a career, from educational requirements and employment opportunities to work duties and conditions in the work environment. Make students aware that even though interests, attitudes, and work values are important factors in making career decisions, theywhould also consider the importance they place on change, risk taking, and helping others. Involve students in research activities to develop their awareness of woodwork careeers. Point out that many people are employed in these job categories:	Working with Wood, McKnight Publishing, Chapter 49 Careers: An Overview, Prentice-Hall Career Awareness Resource Library (videorecordings), Library, Manitoba Department of Education A Career in Cabinet Making (kit), Library, Manitoba Department of Education The World of Woodworking - Part I (filmstrip, cassette), School Services of Canada

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	a) Unskilled workers assist semiskilled workers with tasks related to the handling and moving of materials and the maintaining of the work areas. b) Semiskilled workers help skilled workers operate machines and equipment, assemble various manufactured parts into a single final product, and inspect and test manufactured items to determine whether they operate satisfactorily. c) Skilled workers, following an apprenticeship program, perform the exacting work and skills of the woodwork trade, such as carpentry, cabinetmaking, and pattern making. d) Semiprofessional workers include salespeople who know about different woods and their uses, retail lumber salespeople who read working drawings and calculate the kind, amounts, and costs of material, and draftspeople who know how structures are to be built. e) Professional workers, such as those listed below, require college or other post-secondary education: . foresters working in forest management, conservation, and research; . furniture designers having learned methods for building furniture and ways to select and use wood appropriately;	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	. engineers seeking new ways to use wood in manufacturing and construction and working in laboratories to test the strengths of different wood; . architects designing buildings, determining the quality and type of materials to be used in them, and checking the work as it is being done; . real estate brokers selling land and buildings, having learned how structures are designed and built and how to judge the value of a building based on size, location, type of construction, and market; . managers working in lumbering, forestry, sawmills, lumber yards; . industrial arts teachers giving woodwork instruction. Have students enhance their knowledge of woodwork careers by taking part in individual and group projects like these: . preparing lists, charts, and displays of occupations made possible directly or indirectly by woodwork industries; . researching and listing various woodwork industries in the local community and in the province of Manitoba, classifying them according to the types of woodwork they perform and the occupations represented;	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	. writing an illustrted report on a woodwork industry by following an outline like this: history and growth of the industry, number of people employed, kind of products made, kinds of occupations, kinds of skills and education needed, salaries and benefits; . viewing films and preparing displays about the use and influence of computer technology and robotics on woodwork occupations; . visiting open-house day at a secondary school.	

IV. MEASUREMENT (C.)

Estimated Time: 4 hours

MAJOR OBJECTIVE: To procure knowledge and skills related to imperial and SI metric systems of measurement and measuring devices and to apply the knowledge and skills to measurement activities and problems pertinent to woodwork.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Integrate measurement instruction and applications throughout each module in the woodwork area of study. Point out the need to follow safety procedures and to make accurate measurements.	
A. INTRODUCTION TO MEASUREMENT The student should be able to:		
1. define measurement;	Discuss and have students prepare a definition of measurement. Emphasize that measurement is a method used to communicate information about size, shape, distance, and weight. Have students give examples of measurements in woodwork related to size, shape, distance, and weight. Make them aware that measurement is made by comparing an unknown quantity with a standard or known quantity.	MEASUREMENT: A method of communicating size, shape, distance, and weight

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
2. explain the importance of measurement;	Make students aware of the relationship between good workmanship and accurate measurements. Have students identify ways in which measurement applies to various aspects of woodwork.	
3. recognize the need for standards;	Explain that standards for measuring in metalwork have been developed over the years and have been agreed upon by people/organizations such as ISO, ANSI, and CSA, with representation from many industries. Indicate that these standards are the same throughout the world and aid in communicating information pertinent to woodwork measurements.	ISO: International Organization for Standardization ANSI: American National Standards Institute CSA: Canadian Standards Association
	Inform students that published standards define and allow measurement of length, volume, area, weight, time, temperature, and other values.	Standard Measurement (colour 16 mm film), Library, Manitoba Department of Education
4. identify the basic types of quantity measurement;	Identify and discuss the basic kinds of quantity measurement. Have students prepare charts, posters, displays, or reports about the basic types of quantity measurement.	BASIC TYPES OF QUANTITY MEASUREMENT 1. Length 2. Mass 3. Time 4. Temperature 5. Electric current 6. Amount of a substance 7. Light intensity

<table>
<tr><th>TOPICS AND OBJECTIVES</th><th>SUGGESTED ACTIVITIES AND NOTES</th><th>RESOURCES</th></tr>
<tr>
<td>5. give application examples of SI metric and imperial units of measurement used in woodwork.</td>
<td>
<p>Explain and have students identify SI metric and imperial units of measurement used in various woodwork activities. Have students prepare charts for their notebooks of SI metric and imperial units of measurement and their applications in the woodwork industry. Emphasize the following:</p>
<p>UNITS OF MEASURE</p>
<table>
<tr><th>QUANTITIES</th><th>SI METRIC UNITS</th><th>IMPERIAL UNITS</th><th>APPLICATIONS</th></tr>
<tr><td>Length, distance</td><td>metre</td><td>yard
foot, inch</td><td>Linear measurements
Thickness, width, and length of wood material</td></tr>
<tr><td></td><td>millimetre</td><td>foot, inch</td><td>Length and width of wood products and buildings</td></tr>
<tr><td></td><td></td><td></td><td>Layout work and measurements in respect to constructing parts of wood products</td></tr>
<tr><td>Area</td><td>square millimetre, square centimetre, square metre</td><td>square inch, square foot, square yard</td><td>Area of parts of wood products, wood products, and wood buildings</td></tr>
<tr><td>Volume</td><td>cubic millimetre, cubic centimetre, cubic metre</td><td>cubic inch, cubic foot, cubic yard</td><td>Volumes of various types of wood stock</td></tr>
<tr><td>Mass/ Weight</td><td>kilogram</td><td>pound</td><td>Quantity unit of nails</td></tr>
<tr><td>Temperature</td><td>degrees Celsius</td><td>degrees Fahrenheit</td><td>Temperature related to drying of finishes</td></tr>
<tr><td>Pressure</td><td>KPa
MPa</td><td>p.s.i.</td><td>Pressure and stress related to woods</td></tr>
</table>
</td>
<td>
<p><u>Woodworking Tools, Materials, Processes</u>, American Technical Publishers, Unit 2</p>
<p><u>General Woodworking</u>, Second Canadian Edition, SI metric, McGraw-Hill Ryerson, Unit 7</p>
<p><u>Working with Wood</u>, McKnight Publishing, Chapter 5</p>
<p><u>Basic Industrial Arts Woodworking</u>, McKnight Publishing, Chapter 3</p>
<p><u>Metric Measurement I: Measurement and Why We Need a Standard Measurement</u>, <u>Metric Measurement II: What Is the Metric System and How Is It Used?</u> (16 mm colour films), Library, Department of Education</p>
</td>
</tr>
</table>

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
D. MEASURING DEVICES		
The student should be able to:		
1. identify common measuring tools;	Acquaint students with common tools related to measuring. Point out that the tools are used to measure and mark wood stock. Help students identify the tools by having them prepare labelled charts, posters, and displays of the common tools.	COMMON MEASURING TOOLS 1. Rules 2. Flexible tapes 3. Dividers 4. Pencils, awls, knives 5. Squares 6. Sliding T-level 7. Chalk lines 8. Templates 9. Marking gauge 10. Plumb bobs 11. Levels
2. use common measuring tools;	Demonstrate the use of common measuring tools and provide students with opportunities to use them.	
	Discuss the importance of using tools correctly and safely and of keeping them in good working condition in relation to projects and products in woodwork.	Basic Industrial Arts Woodworking, McKnight Publishing, Chapter 3 General Woodworking, Second Canadian Edition, SI metric, McGraw-Hill Ryerson, Units 7, 11
	Demonstrate the procedures for measuring thickness, length, and width of various types of wood stock and assign similar measuring activities. Have students practice measuring items found in the woodworking laboratory and classroom.	Woodworking Tools, Materials, Processes, American Technical Publishers, Units 2, 7

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
3. recognize the need for precision measuring instruments in woodwork;	Point out that accurate measurement is essential to the safe mass production of interchangeable wood parts by discussing the following: a) Every part must be accurately made to the size and shape specified. b) Parts made inaccurately will not fit properly with other parts. c) If inaccurate measurements have been made, finished products can malfunction or wear out too soon. d) Parts manufactured at one location are often assembled with other parts at another location. e) The safety of individuals can be dependent upon accurate measurements.	Accurate Measuring and Layout Tools (colour filmstrip, cassette), School Services of Canada Tools for Measuring Wood (colour filmstrip, cassette), AIM Educational Aids Meauring Tools, Basic Layout Techniques (colour filmstrips, cassettes, study guides), McIntyre Educational Media Measuring and Layout Tools, Measuring and Squaring (16 mm film), Library, Manitoba Department of Education
	Emphasize that precision measurement is a fact of life today. Ask students to illustrate this concept by way of posters, displays, reports, experiments, and demonstrations.	Accurate Measuring and Layout Tools (Woodworking), Hand Tools (B) (series filmstrips, cassettes), School Services of Canada
4. identify precision measurement instruments;	Show examples or illustrations of precision measurement instruments. Have students prepare labelled charts, posters, or displays of precision measurement instruments. Discuss the influence of technology on precision measurement; e.g., electronic micrometer.	PRECISION MEASUREMENT INSTRUMENTS 1. Calipers 2. Micrometers

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Have students use different sizes of cardboard mailing tubes to make a large working model of the hub and thimble of a micrometer.	
5. use precision measurement instruments.	Demonstrate and have students use the correct procedures for measuring with precision instruments available in the laboratory. Explain the need to care for and maintain these instruments so they will function accurately.	Working with Wood, McKnight Publishing, p. 266

V. DESIGN AND CONSTRUCTION (C.)

Estimated Time: 5-8 hours

MAJOR OBJECTIVE: To obtain knowledge and skills related to the principles of planning and design and to apply the knowledge and skills to plan, design, and construct woodwork projects and products.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Emphasize planning and design throughout all modules in this area of study.	
A. PLANNING FOR WOODWORK The student should be able to:		
1. define planning;	Have students discuss and define planning. Point out that woodwork products/projects must be planned before they can be manufactured. Make students aware that planning involves two important resources, people and things, to meet human needs.	PLANNING: The process of identifying and preparing details to be considered before manufacturing begins
2. develop an understanding of the importance of planning;	Point out, citing examples, that planning for various products/projects begins some time before the actual work starts.	
3. identify the components of planning.	Emphasize that planning for woodwork is a cooperative process, requiring many people to use resources, equipment, and tools effectively to meet the needs of society, business, industry, and individuals. List, discuss, and define the components of plan-	COMPONENTS OF PLANNING 1. Formulating 2. Researching 3. Designng 4. Engineering

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	ning. Make students aware of the relationship of long-term and short-term planning to woodwork.	FORMULATING: The process of deciding what to manufacture to meet needs RESEARCHING: The process of gathering facts to assist with decision-making DESIGNING: The process of developing and creating a plan to meet needs
	Emphasize the importance of scheduling and coordinating for the completion of projects and products in woodwork. Point out that improper planning can lead to higher costs and to wasted motion, materials, and effort.	ENGINEERING: The process of adding details to the design and of scheduling manufacturing
B. DESIGNING FOR WOODWORK The student should be able to:		
1. recognize the importance of design;	Review the definition of *designing*. Point out that it involves creative planning and original work, rather than copying, to meet societal, industrial, business, and human needs. Encourage students to enhance their knowledge about the importance of design in woodworking. Have students study catalogues, magazines, and newspapers and visit stores and craft shops to increase their understanding of the importance of design.	*General Woodworking*, Second Canadian Edition, SI metric, McGraw-Hill Ryerson, Unit 5 *Woodworking Tools, Materials, Processes*, American Technical Publishers, Unit 4

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
2. identify the requirements for design;	Emphasize that good design in woodwork means meeting these requirements: strength, function, appearance, materials, cost, and quality.	Working with Wood, McKnight Publishing, Chapter 2
3. explain the relationship of design to strength, function, appearance, materials, cost, and quality;	Discuss the influence of design requirements on the design process. Have students consider the following questions: a) Strength--Will the design result in a strong and durable product? b) Function--Does the design fit the purpose for which it was planned? c) Appearance--Do the parts appear to belong together and is the product pleasant to look at, live with, and use? d) Materials--Have the materials been used effectively? e) Cost--Does the cost relate to strength, function, appearance, materials, and quality of the finished product? f) Quality--Is quality an inherent part of the finished product? Indicate that these interrelated requirements apply to all designs.	DESIGN REQUIREMENTS 1. Strength 2. Function 3. Appearance 4. Materials 5. Cost 6. Quality
4. describe the basic elements of designing;	Identify and have students define each of the design elements. Point out the relationship of these elements to the design requirements and principles.	LINE: Establishes expression, leads the eye in a particular direction, and outlines surfaces and contours of form

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
		SHAPE: Determines whether an object is pleasing to look at or touch and relies on line, colour, and surface texture SPACE: Volume which an object occupies, including openings COLOUR: Creates special effects such as warmth, coolness, and distance TEXTURE: Indicates the surface condition, can be felt and seen, and can be related to the pattern
5. explain the principles of design;	Provide students with information about these principles of design: balance, proportion, rhythm, harmony, unity, emphasis, and variety. Make them aware that the principles influence the organization or arrangement of the elements of a woodwork product so that it is pleasing to view. Show them examples, illustrations, and models of various types and styles of woodwork. Ask them to examine and assess the illustrations and models by answering these questions about the application of the design principles: a) Balance--Do the different parts seem to have the same mass or value? Are the parts on each side of the centre line alike in size and shape?	PRINCIPLES OF DESIGN 1. Balance 2. Proportion 3. Rhythm 4. Harmony 5. Unity 6. Emphasis 7. Variety Woodworking Tools, Materials, Processes, American Technical Publishers, Unit 4 Working with Wood, McKnight Publishing, Chapter 2

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	b) Proportion--Does the size of one part of a product relate well to the rest? How does the function of an object control the proportion? c) Rhythm--Are the elements or features such as lines, curves, forms, colours, and textures repeated? Do they give the object a pleasing appearance? d) Harmony and Unity--Do the parts of an object appear to belong together? e) Emphasis--Does the design have a point of interest? What is the point of interest? f) Variety--Are different materials, shapes, and colours used to give an interesting and lively appearance to the product?	General Woodworking, Second Canadian Edition, SI metric, McGraw-Hill Ryerson, Unit 5 Elements of Good Design, Furniture Styles (colour filmstrips, cassettes, program guide, reproducible masters), Prentice-Hall Media
6. identify steps in the design process.	Explain the steps pertinent to the design process for the development of projects/ products in woodwork. Encourage students to think of projects/products as design problems and to use planning sheets to go through these steps: a) Statement of the problem--What is the purpose of the project/product and how will it be used? b) Analysis and research--Think through the problem. What must the project do? What are the needs or characteristics? What are some of the limitations to be considered? In what ways have others solved similar problems?	STEPS IN THE DESIGN PROCESS 1. Statement of the problem 2. Analysis and research 3. Possible solutions 4. Experimentation 5. Final solution

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	c) Possible solutions--Develop ideas. What types of charts, sketches and related labels and notes are necessary to portray the ideas and to determine the materials required to carry out the ideas? Is it necessary to improve the sketches and notes to make a better design? d) Experimentation--Prepare several models or mockups of the design from paper, cardboard, clay, wood, styrofoam, plasticene, or other easily manipulated material. Point out that mockups can be smaller or larger than the project but should be built to scale and that the material chosen for the mockups should be cheaper than the material chosen for the actual project and should be easy to cut and shape. What methods of joining and forming materials should be used? What new materials could be used to improve the design? In what ways should the design be changed or improved? e) Final solution--Develop working drawings and a worksheet for the selected solution to the problem and construct the project/product. How should the drawings be used during the construction process? What parts are required? In what order should the operations be completed?	Basic Industrial Arts Woodworking, McKnight Publishing, Chapter 2 General Woodworking, Second Canadian Edition, SI metric, McGraw-Hill Ryerson, Unit 6 Woodworking Tools, Materials, Processes, American Technical Publishers, Unit 5 Working with Wood, McKnight Publishing, Chapter 3 MOCKUP: A model built from a sketch to show how a project will look after it is built

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	DESIGN PLAN SHEET NAME OF STUDENT ____________ DATE: ________ CLASS: ________ STATEMENT OF THE PROBLEM: ____________ ____________ ____________ NAME OF CHARACTERISTICS: ____________ ____________ ____________ ____________ ____________ ____________ IDEA SKETCHES:	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES

WORKSHEET

STUDENT ____________________ DATE ____________________

PROBLEM ____________________ CLASS ____________________

A. LIST OF PARTS

# PART NAME	MATERIAL SIZES L	W	T	MATERIAL	#REQ'D	COST
1						
2						
3						
4						
5						
6						
7						
					TOTAL	

B. ORDER OF OPERATIONS

STEP	OPERATION	MACHINE OR TOOL REQ'D
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Have students present their models to the class to obtain suggestions for improvements and changes. Encourage students to compile notebook records of their own ideas and of ideas collected from periodicals, newspapers, and reference books for projects/products. Have them read and study publications on design to acquire more information about the relationship between projects/products and design. Make students aware that it takes time and practice to acquire the skill and knowledge to solve design problems.	
C. PROJECT CONSTRUCTION The student should be able to:		
1. develop an understanding of the importance of sketches, working drawings, and stretchouts/patterns;	Show students examples of sketches, working drawings, and stretchouts/patterns and discuss their importance in the design and construction process. Emphasize that sketches are diagrams portraying ideas related to the possible views, shapes, and sizes of products/projects. Explain that working drawings give all the information needed to make the product and must show the following items: shapes of parts,	Basic Industrial Arts Woodworking, McKnight Publishing, Chapter 2 The Basic Book of Woodworking, American Technical Society, Unit 3 Working with Wood, McKnight Publishing, Chapter 2

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	sizes of parts, kinds of materials, types of finishes, and number of pieces required for each part. Point out that a stretchout/pattern is a full-size drawing of the product/project on a single plane. Show examples of stretchouts/patterns.	The Basic Book of Woodworking, American Technical Society, Chapter 8 Woodworking Tools, Materials, Processes, American Technical Publishers, Section 11 General Woodworking, Second Canadian Edition, SI metric, McGraw-Hill Ryerson, Section 9 Working with Wood, McKnight Publishing, Section IX
2. interpret sketches, working drawings, and stretchouts/patterns;	Explain how to read and extract information from sketches, working drawings, and stretchouts/patterns and provide students with opportunities to read and interpret these.	Basic Blueprint Reading and Sketching, Delmar Publishers
3. prepare sketches, working drawings, and stretchouts/patterns;	Point out that diagrams, especially working drawings and stretchouts/patterns, are drawn with certain kinds of lines, signs, and abbreviations. Acquaint students with these. Demonstrate and have students use the procedures for preparing sketches, working drawings, and stretchouts/patterns for woodwork products/projects.	How to Draw a Working Plan--Part One and Two, Basic Layout Techniques (colour filmstrips, cassettes, study guide), McIntyre Eduational Media Basic Layout Tools: Care of Layout Tools (16 mm film), Library, Department of Education Woodworking: Layout (colour filmstrip series, cassettes, program guide, reproducible masters), Prentice-Hall Media

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
4. construct and evaluate products/projects.	Have students use the information prepared on design plan sheets, work sheets, sketches, working drawings, and stretch-outs/patterns to construct products/projects. Encourage them to assess the construction process, including the use of tools, and the completed products/projects on the bases of planning and design principles and by comparing the input of materials, labour, energy, and other resources to the quality of workmanship and the time and money expended.	

VI. CONSUMERISM (C.)

Estimated Time: 3 hours

MAJOR OBJECTIVE: To explore the economic system and the economy in relation to woodwork and consumer awareness.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Integrate instruction in consumerism throughout this area of study, encouraging critical thinking about it and point out its application to businesses and individuals.	
A. ECONOMIC SYSTEMS AND WOODWORK The student should be able to: 1. define economic system;	Explain the term economic system. Emphasize that the term refers to the following: a) The way individual workers and managers, productive organizations such as factories or farms, and government agencies are linked together to form a system, a unit, or an organization. b) The way decisions are made as to how workers, productive organizations, and government agencies will solve the basic economic questions each nation, province, and local community faces.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	List and discuss the basic economic questions. Point out that these questions relate to woodwork businesses, services, and products and to consumers of these services and products. Make students aware that political, social, religious, and moral systems, which influence economic systems, change from one country to another and within a single country over a period of time. Point out that by using and consuming resources, the various economic systems produce woodwork goods and related services for consumers. Explain that the following economic activities provide resources for woodwork goods and services: mining, manufacturing, agriculture, and construction. Make students aware of the need for individuals and businesses to choose goods and services wisely and to use resources effectively during the production of woodwork goods and services.	BASIC ECONOMIC QUESTIONS 1. What to produce? 2. How to produce it? 3. Who will receive the services and finished products? 4. How much to produce over a period of time?
2. explain the basic parts of economic systems;	Identify and discuss the basic parts required by economic systems to produce goods and services: inputs, processes, and outputs. Make students aware of these parts in relation to woodwork businesses, services, and products. Emphasize the folowing:	BASIC PARTS OF ECONOMIC SYSTEMS 1. Inputs 2. Processes 3. Outputs

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	a) Inputs are resources required to produce goods and services. b) Processes are work activities required to produce goods and services. c) Outputs are goods and services produced by an economic system. Have students give examples of inputs, processes, and outputs for work activities related to woodwork.	
3. identify basic types of inputs.	Review the definition of inputs. List and discuss the basic types of inputs. Emphasize that the basic inputs are common to various organizations, such as schools, families, clubs, and businesses. Discuss the relationship among the basic inputs and their application to the production of goods and services for consumption by businesses, organizations, and individuals.	BASIC TYPES OF INPUTS 1. People 2. Knowledge and skills 3. Industrial resources 4. Utilities 5. Finance
B. WOODWORK AND CONSUMERISM The student should be able to:		
1. identify human needs;	Make students aware of the importance of the following human needs: physical, societal, intellectual, and emotional. Relate Maslow's hierarchy of human needs to the services and products of woodwork.	Looking at the Consumer, Gage Publishing The Confident Consumer, Goodheart-Willcox

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Encourage students to identify basic physical, societal, intellectual, and emotional needs. Point out the relationship between these needs and woodwork work activities, services, and products.	MASLOW'S HIERARCHY OF HUMAN NEEDS 1. Physical needs 2. Security 3. Love and acceptance 4. Esteem 5. Self-actualization
2. explain how woodwork meets human needs;	Emphasize that woodwork and various related services and products are available in different economic systems. Have students compile lists or prepare charts, displays, or written reports about the different types of woodwork services and products, explaining the need of society, businesses, and individuals for each. Ask students to explain how the services and products provided by woodwork help society and individuals to meet the basic needs of shelter, food, water, and clothing.	Charts Bulletin board displays
3. recognize the relationship between woodwork and the economy.	Relate various industrial and business activities to national, provincial, regional, and local levels of the economy. Have students investigate the effects of industrial and business activities on employment and businesses related to woodwork. Make students aware of the ways in which industries, businesses, and individuals use the services and products of woodwork to produce other services and goods for various sectors of the economy.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
C. WOODWORK AND THE MARKETPLACE		
	Point out why prospective users of the services and products of woodwork should develop an understanding of the marketplace and its relationship to the economy.	
The student should be able to:		
1. differentiate between needs and wants;	Have students compile lists of services and products of woodwork desired by individuals. Have them recognize the difference between needs and wants. Make them aware of businesses that need and want services and products of woodwork.	The World of Business: A Canadian Profile, Wiley Publishers of Canada, Chapter 18 NEEDS: Things required by an individual for basic life and survival WANTS: Things desired by an individual for pleasure and comfort
2. recognize the concept of quality versus cost;	Discuss the following concepts: quality versus cost, cost versus application, influence of demand on supply and cost, state of the economy, financing, and advertising. Relate these concepts to the users and producers of the services and products of woodwork. Show students two woodwork products which look alike and have them examine the products carefully to indicate the value of judging products before buying them.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
3. explain the role of supply and demand;	Make students aware of the relationship of these concepts to the services and products of woodwork: . planning and design; . human needs; . availability and use of resources; . employment; . availability and choice of various services and products. Ask students to list things they would look for in buying specific woodwork products. Have them visit local stores and report on various grades and prices of woodwork articles.	
4. describe the effects of inflation;	Explain the major causes and effects of inflation. Make students aware of the effect of inflation on individuals, industries, and businesses in general and on industries and businesses related to woodwork in particular.	
5. identify the positive and negative aspects of credit buying;	Discuss the direct and indirect costs and the advantages and disadvantages of credit to individuals and businesses. Have students compare the costs of items, particularly woodwork items, purchased on cash and credit terms by individuals and businesses.	Looking at the Consumer, Gage Publishing, Chapter 3

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
6. explain the purpose and influence of advertising;	Define advertising. Discuss the purpose and influence of advertising on various types of woodwork products and services. Have students collect information about and examples of advertising for displays and reports. Make students aware of the relationship of advertising to cost, supply and demand, and needs and wants pertinent to woodwork products. Discuss advertising psychology and propaganda and point out that some advertising attempts to persuade people to buy regardless of need, or ability to pay. Encourage students to study advertisements/sales promotions carefully and to sift out propaganda and false advertising from honest sales efforts.	TYPES OF ADVERTISING MEDIA 1. Direct mail 2. Computers 3. Newspapers 4. Periodicals 5. Radio 6. Signs 7. Television
7. recognize the relationship of sources of materials to the services and products of woodwork;	Discuss the relationship of material sources to the services and products of woodwork and to the industrial, business, and individual consumers of these services and products. Ask students to identify the various sources of materials pertinent to woodwork products. Encourage students, individually or in groups, to research information for the preparation of bulletin board displays, charts, scrapbooks, or illustrated reports on the development of wood products from various sources.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
8. explain the consequences pertinent to the consumption of woodwork products;	Have students identify the uses of woodwork products in homes, farms, businesses and industries, communication, transportation, science, and medicine. Have them discuss the need for continued research related to sources of materials for woodwork.	
9. justify the need for conservation and cost consideration of materials.	Discuss and have students develop and demonstrate, through research and projects, an understanding of the importance of conservation and cost consideration pertinent to the consumption of materials by industry, business, and individuals. Ask students to consider the relationship of reforestation and recycling to woodwork. Have them consider conservation and cost of materials in relation to woodwork services and products.	General Woodworking, Second Canadian Edition, SI metric, McGraw-Hill Ryerson, Unit 2

VII. MATERIALS (C.)

Estimated Time: 4-6 hours

MAJOR OBJECTIVE: To acquire information about the nature, source, classification, processing, and properties of woods, and to apply this information to woodwork projects and products.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Integrate instruction related to materials throughout other modules. Emphasize the relationship of materials to safety, measurement, consumerism and conservation, design and construction, forming, fastening, finishings, jigs and fixtures, and mass production.	
A. INTRODUCTION TO WOOD MATERIALS The student should be able to:		
1. develop an awareness of the nature and source of woods;	Discuss the nature of woods by emphasizing the following: a) Forests cover about one-third of the surface of the earth. b) Trees begin from seedlings in nature or in a nursery. c) Environments differ greatly throughout the world, making the forests different. d) Trees require fifteen to twenty or more years of growing time before harvesting can occur.	HARVESTING: Cutting trees to make wood products

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	e) Forestry researchers are searching constantly for ways to increase the production of wood. f) Once harvested, trees are transferred to a lumber mill where they are made into various shapes and sizes of lumber, and dried and graded. g) The processing of lumber from trees to standard wood materials includes logging, making lumber, drying, applying purchasing standards, and sheet manufacturing. h) Some lumber is processed into plywood, veneers, particle board, hardboard, and other types of wood materials.	FORESTRY: Using and maintaining forests General Woodworking, Second Canadian Edition, SI metric, McGraw-Hill Ryerson, Unit 64
2. define woods;	Show students examples or illustrations of woods from various trees and have students discuss and define woods.	WOODS: Materials derived from the hard fibrous substances which make up the greater part of the stems and branches of trees beneath the bark
3. identify geographical locations of forests;	Refer students to maps, encyclopedias, and yearbooks to determine world, Canadian, and Manitoba sources of various types of forests. Ask students to locate on maps and to list the locations of different types of forests. Discuss the influence of environments on the location of various types of forests.	Canada Year Book

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
4. describe the development of forestry and forestry related industries in Manitoba;	Discuss the development of forestry, lumbering, and related industries in Manitoba, and have students view films, prepare illustrated reports, displays, and maps, and collect newspaper clippings related to this topic.	Life of a Tree, Three Faces of Wood (multicoloured transparencies, overlays, instructor's guide), AIM Educational Aids Solid Wood Products, Chemical and Fiber Products, Food and Miscellaneous Products, Annual Growth Sheath, Cross Grain, The Wood Fibre, Cell Wall Pits, Specific Gravity, Determination of Moisture Content, Equilibrium Moisture Content, Origins of Wood Species-Eastern Hemisphere, Origins of Wood Species-Western Hemisphere (colour transparencies, overlays, instructor's guide), AIM Educational Aids
5. recognize the importance of woods.	Have students assess and prove this statement: "Woods are everywhere around us." Ask them to work on group projects (such as posters, displays, and illustrated booklets) to indicate the extensive use of woods in manufacturing and construction. Encourage students to identify items made from wood in their homes, schools, and classrooms.	
B. CLASSIFICATIONS OF WOODS The student should be able to:		
1. describe the two major types of trees;	Point out that the many species of trees can be divided into two basic groups: deciduous and coniferous. Point out that each species has its own leaf shape and type of seed. Ask students to define deciduous and coniferous and to collect leaves and seeds or prepare illustrations of them for a labelled bulletin board display.	DECIDUOUS: Trees, with flat leaves, shedding in autumn CONIFEROUS: Trees, called cone-bearing or evergreen, with needle-shaped leaves retained throughout the year

<table>
<tr><th>TOPICS AND OBJECTIVES</th><th>SUGGESTED ACTIVITIES AND NOTES</th><th>RESOURCES</th></tr>
<tr>
<td>2. compare softwood and hardwood;</td>
<td>Explain that wood is labelled according to the tree from which it is cut. Have students prepare definitions for hardwood and softwood and give examples of woods in each classification. Make them aware that the terms hardwood and softwood do not always indicate the hardness and the softness of wood.</td>
<td>HARDWOOD: Wood cut from deciduous trees

SOFTWOOD: Wood produced from coniferous trees

Working with Wood, McKnight Publishng, Chapters 50, 51</td>
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<tr>
<td>3. classify woods.</td>
<td>Have students discuss these differences:
<table>
<tr><th></th><th>Hardwood</th><th>Softwood</th></tr>
<tr><td>a)</td><td>Hardwood is from deciduous trees.</td><td>Softwood is from coniferous trees.</td></tr>
<tr><td>b)</td><td>Some hardwood is softer than softwood (balsa, a hardwood, is softer than pine, a softwood).</td><td>Some softwood is harder than some hardwood.</td></tr>
<tr><td>c)</td><td>Most hardwoods are open-grained, but some are closed-grained.</td><td>All softwoods are closed-grained.</td></tr>
<tr><td>d)</td><td>Surfaces of hardwoods are rough and porous.</td><td>Surfaces of softwoods are smooth and nonporous.</td></tr>
<tr><td>e)</td><td>Hardwoods have shorter and less flexible fibers.</td><td>Softwoods have longer and more flexible fibers.</td></tr>
<tr><td>f)</td><td>Hardwood cells are different from one another.</td><td>Softwood cells are fairly uniform in kind and size.</td></tr>
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</td>
<td>OPEN-GRAIN: Term for describing wood with large open pores

CLOSED-GRAIN: Term for describing wood with small close-knit pores

General Woodworking, Second Canadian Edition, SI metric, McGraw-Hill Ryerson, Unit 65

Woodworking Tools, Materials, Processes, American Technical Publishers, Unit 54

Basic Industrial Arts Woodworking, McKnight Publishing, Chapter 1</td>
</tr>
</table>

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Encourage students to secure samples of as many woods as possible and to work in groups to mount and label each according to classification.	General Woodworking, Second Candian Edition, SI metric, McGraw-Hill Ryerson, Unit 73
	Have students conduct experiments to distinguish hardwoods from softwoods and to observe the difference in their cell sizes. Emphasize that cell structure affects the splitting of wood when railing.	Microstructure of Softwood, Microstructure of Hardwood, Softwoods-Comparative Physical Properties, Hardwoods-Comparative Physical Properties (colour transparencies, overlays, instructor's guide), AIM Educational Aids
C. PROCESSING TREES AND LUMBER		
	Point out that raw materials such as trees must be processed to provide material of standard size and quality for the manufacture of useful wood products.	
The student should be able to:		
1. identify the basic steps in processing trees and lumber;	Emphasize that trees and lumber must go through several basic steps to be processed into solid wood, plywood, composition wood, and wood-related products such as pulp and paper.	COMMON BASIC STEPS FOR PROCESSING TREES 1. Harvesting 2. Transporting 3. Debarking

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
		4. Cutting 5. Grading 6. Drying 7. Surfacing
2. explain the basic steps in processing trees and lumber;	Ask students to research reference sources to collect information about the processing of trees and lumber. Divide students into groups to prepare reports, flowcharts, and displays on one of these topics: . logging and sawmill processes; . grading lumber; . surfacing lumber; . drying lumber; . pulp and paper processes.	General Woodworking, Second Canadian Edition, SI metric, McGraw-Hill Ryerson, Unit 66 Lumber, The Manufacture of Lumber (colour transparencies, overlays, instructor's guide), AIM Educational Aids Lumbering (colour filmstrip, cassette, program guide, reproducible masters), Prentice-Hall Media
	Give students cross-sectional views of a tree trunk and have them show, by drawing lines, plain-sawed and quarter-sawed lumber. Have students conduct and report on an experiment determining the surface characteristics of plain-sawed and quarter-sawed lumber. Have students conduct and report on experiments determining the moisture content of a piece of wood and measuring the effect of heat on "wood shrinkage."	General Woodworking, Second Canadian Edition, SI metric, McGraw-Hill Ryerson, Unit 74
3. develop an understanding of the production of plywoods;	Have students define plywood and trace in charts, displays, and reports, the manufacturing process of hardwood and softwood plywood. Acquaint students with these	PLYWOOD: A construction material made by gluing together thin layers of wood at right angles

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	different types of cores used in the manufacturing of plywood: veneer, lumber, and particle cores. Ask them to compare the different types of cores on the basis of warpage, fastening, and durability. Give students three plies of veneer and the necessary equipment to produce a four-inch square of plywood.	Woodworking Tools, Materials, Processes, American Technical Publishers, Units 57-61 Basic Industrial Arts Woods, McKnight Publishing, Unit 1 General Woodworking, Second Canadian Edition, SI metric, McGraw-Hill Ryerson, Units 67, 68
4. identify the types of composition woods;	Have students prepare and display samples of various types of particle board and chip board/hardboard. Acquaint them with the different grades and the advantages and disadvantages of particle board and chip board/hardboard.	Veneer, Plywood, The Manufacture of Plywood, Hardboard, The Manufacture of Hardboard, Particleboard, The Manufacture of Particleboard (colour transparencies, overlays, instructor's guide), AIM Educational Aids
5. develop an understanding of the production of composition woods;	Have students prepare research reports and displays on the ingredients and production processes related to particle board and to chip board/hardboard. Have students produce/press out a small sample of particle board from wood chips and a small sample of chip board/hardboard from sawdust (if equipment and supplies are available).	Processed Wood Products (colour filmstrip, cassette, program guides, reproducible masters), Prentice-Hall Media

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
6. identify the types of covering used on plywood and composition boards;	Have students display samples of plywood and composition board with specialty covering, such as lithographing, embossing, plastic laminating, painting, or prefinishing.	General Woodworking, Second Canadian Edition, SI metric, McGraw-Hill Ryerson, Unit 69
7. define standard stock;	Point out that woods, plywoods, and composition boards are produced in many shapes and sizes and that a lumber wholesaler carries a supply, or stock, of different kinds of wood materials of different shapes and sizes.	STANDARD STOCK: Common shapes and sizes in which woods, plywoods, and composition boards are manufactured, measured, and purhased/sold The Basic Book of Woodworking, American Technical Society, Unit 4
8. identify the various shapes and sizes of common wood materials;	Discuss and show students illustrations and examples of various shapes and sizes of common wood materials. Take students on a visit to a lumber yard to view the common wood materials.	Woodworking Tools, Materials, Processes, American Technical Publishers, Units 56, 57, 58, 59, 60
9. explain the relationship of common shapes to sizes, measuring, and ordering of wood materials.	Make students aware of the sizes of sheets, boards, dimension lumber, and timbers. Have students refer to lumber catalogues for information required to order wood materials required for projects. Emphasize the need to describe each item accurately and clearly.	General Woodworking, Second Canadian Edition, SI metric, McGraw-Hill Ryerson, Units 8, 9

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
D. PROPERTIES AND USES The student should be able to:		
1. explain the classifications of wood properties;	Point out that the properties of woods determine the type best suited for specific jobs. Use discussion, demonstration, and experimentation to explain these principles related to the classification of wood properties: a) Mechanical properties indicate how wood reacts to various forces such as tension (bending) and compression (squeezing). b) Non-mechanical/physical properties result from the internal structure of wood and include density (weight of a given size), moisture content, specific gravity, conductivity (ability to transfer heat or to carry electricity). c) Chemical properties relate to the way in which wood behaves upon contact with gases and fluids.	Woodworking Tools, Materials, Processes, American Technical Publishers, Unit 54 Wood Properties, Evaluation of Wood Strength (colour transparencies, overlays, instructor's guide), AIM Educational Aids Physical Properties (colour filmstrip, cassette, program guide, reproducible masters), Prentice-Hall Media
2. explain the common properties of woods;	Make students aware of the importance of understanding the common properties of woods and have them list and explain each of the properties complete with examples.	COMMON PROPERTIES OF WOODS 1. Appearance 2. Workability 3. Durability

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Have students perform experiments on the mechanical, physical, and chemical properties of wood and list conclusions after each experiment.	4. Specific gravity 5. Density 6. Electrical properties 7. Thermal conductivity 8. Thermal expansion 9. Flamability 10. Corrosiveness 11. Permeability 12. Bending strength 13. Shearing strength 14. Tensile strength 15. Compression strength 16. Toughness and shock resistance 17. Hardness
3. select woods, according to properties, for various products;	Show or have students locate products made from wood. Ask students to state reasons, based on properties, why different types of woods were used in different products. Have them choose woods for their projects/products, and give reasons for their choices. Point out that selecting proper materials for projects/products and giving reasons for the selection are very important functions in industry.	Basic Industrial Arts Woodworking, McKnight Publishing, Chapter 1
4. combine other materials with woods.	Ask students to examine wood products and list other materials included in them. Emphasize that the inclusion of other materials adds variety to product appearance and design. Encourage students to research and then to experiment with combining new materials in woodwork products. Have them relate the principles of planning and design to the foregoing activities.	

VIII. SEPARATION (C.) Estimated Time: 6-9 hours

MAJOR OBJECTIVE: To obtain knowledge and skills related to separation processes and to the use, care, and maintenance of hand and power tools applicable to these processes in woodwork.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Integrate instruction in separation throughout other modules in the woodwork area of study. Make students aware of the relationship of separation to safety, measurement, materials, conservation of materials, planning and design of products, and mass production.	
A. METHODS OF SEPARATING WOODS The student should be able to:		
1. define separating;	Emphasize that during the process of building/manufacturing woodwork products or components, the wood materials must be separated. Have students discuss and define separating.	SEPARATING: Shaping material by removing portions of it
2. identify methods of separating woods;	Hold a "brainstorming" session to provide students with an opportunity to identify the various methods of separating woods. Point out that except for shearing all of these methods are classified as the chipping or chip removal process.	METHODS OF SEPARATING 1. Sawing 2. Planing and scraping 3. Drilling and boring 4. Chiselling and gouging

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TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
		5. Routing 6. Shaping 7. Turning 8. Smoothing and sanding 9. Shearing
3. develop an understanding of the principles related to the separation processes.	Discuss the basic principles related to separation processes by emphasizing the following: a) Wood can be cut to the desired shape. b) Holes can be cut into a piece of wood. c) Unwanted wood can be removed from the surface of a piece of wood. d) Notches or pieces of wood can be cut from the ends or edges of wood pieces. Point out the importance of safety precautions and procedures pertinent to each of the separation methods.	
B. HAND AND POWER TOOLS FOR SEPARATING The student should be able to:		
1. identify common hand tools for the separation processes in woodwork;	Show students examples or illustrations of common hand tools used in the separation processes. Have them identify each tool by name. Give students the names of the separation processes and have them select the hand tools used for each.	Cutting Tools, Wood Planes (colour filmstrips, cassettes, study guide), McIntyre Educational Media

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Have students prepare notebook charts illustrating the various types of saws, planes, drills, chisels, files, rasps, sanders, abrasives, and scrapers and explain their purposes.	COMMON HAND TOOLS FOR SEPARATION PROCESSES Saws--crosscut, ripsaw, compass, keyhole, backsaw, miter, dovetail, hacksaw, coping Planes--smooth, jointer, jack, block, rabbet, router Scrapers--spokeshave, cabinet, hand Drills--bit brace, breast, hand, push, bit gauge, countersink, auger, expansive, forstner, multi spur, plug cutting, spade, twist Chisels--butt, carving, firmer, gouge, mortise, socket/shank, tang, wood turning Files and rasps--single-cut, double-cut, flat, half round, cabinet, round rasp, square, surform, three-square Sanders and abrasives--sanding block, natural abrasives (flint, garnet, emery), synthetic abrasives (aluminum oxide, silicon carbide, steel wool) Chisels, Files and Filing, Hand Saws, Hand Saws: Cross Cut and Rip, Planes, Scrapers and Abrasives, Scroll Saw, Sharpening Chisels, Plane Irons, and Gouges (16 mm films), Library, Department of Education

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
2. use hand tools applicable to separation processes;	Demonstrate procedures for the accurate use of hand tools applicable to separation processes. Provide students with opportunities to practice the separating processes on scrap wood materials. Discuss and demonstrate safety checks and proper care and maintenance of the various hand tools.	Woodworking: Hand Tool Operations (filmstrip series, cassettes, guide, reproducible masters), Prentice-Hall Media General Woodworking, Second Canadian Edition, SI metric, McGraw-Hill Ryerson, Units 12-20, 29, 30 Working with Wood, McKnight Publishing, Chapters 8-11 Woodworking Tools, Materials, Proesses, American Technical Publishers, Units 7-11
3. perform separation with hand tools with an increasing degree of accuracy;	Demonstrate correct use, care, and maintenance of hand tools, and point out how this relates to the production and performance of top-quality work. Give frequent performance tests on the tools used in the separation processes.	Basic Industrial Arts Woodworking, McKnight Publishing, Chapters 4-6 The Basic Book of Woodworking, American Technical Society, Units 6, 11, 12, 13, 16, 17, 19, 20, 21 How to Cut Stock, Planing, Drilling and Boring, Sanding (colour filmstrips, cassettes, study guide), McIntyre Educational Media Planes and Their Uses, Saws and Sawing, Various Woodworking Operations (colour filmstrips, cassettes, guide, reproducible masters), Prentice-Hall Media

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
4. identify common power tools for the separation processes in woodwork;	Show students examples or illustrations of common power tools for the separating processes. Have them identify each tool by name. Give students the names of the separation processes and have them select power tools to use for each. Use visual and audio-visual aids to introduce power tools not available in the laboratory. Have students prepare illustrated research reports on new developments in machining tools. Have students prepare wall charts and posters illustrating the various categories of power tools and reports on the purposes of each.	COMMON POWER TOOLS FOR SEPARATION PROCESSES Saws--band, circular, miter box, portable circular, portable reciprocating, radial arm, scroll Planes--jointers, portable power plane, planer/surfacer Drills--drill press, portable electric drill Sanders--belt (portable, stationary), disc (portable, stationary), finishing, block, orbital, reciprocating, spindle drum Lathe Router Shaper Band Saw, The Drill Press, Lathe-Face Plate Turning, Lathe-Spindle Turning, Portable Electric Sander, Power Drills, Scroll Saw, Wood Turning (16 mm films), Library, Department of Education Woodworking: Power Tools, Woodworking: Power Saws, Woodworking: Power Machines (filmstrip series, cassettes, guide, reproducible masters), Prentice-Hall Media

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
5. use power tools applicable to separation processes;	Demonstrate procedures for the accurate use of power tools to perform separation processes. Provide students with opportunities to practice separation processes using available power tools and scrap wood materials. Emphasize safety and care and maintenance of power tools. Discuss and demonstrate safety checks for various power tools. Make students aware of the advantages and disadvantages of power tools.	Woodworking Tools, Materials, Processes, American Technical Publishers, Units 28-44 General Woodworking, Second Canadian Edition, SI metric, McGraw-Hill Ryerson, Units 31-47 Working with Wood, McKnight Publishing, Chapters 31-44 The Basic Book of Woodworking, American Technical Society, Units 7-10, 14, 15, 18, 22-23
6. perform the separation processes with power tools with an increasing degree of accuracy.	Demonstrate the correct use, care, and maintenance of power tools, and relate this to the production and performance of top-quality work. Give frequent performance tests on the power tools available in the laboratory.	Basic Industrial Arts Woodworking, McKnight Publishing, Chapters 4, 5 Woodworking Machine Operations Explained (series of colour filmstrips, cassettes, study guide), McIntyre Educational Media Woodworking: Power Tools (series of colour filmstrips, cassettes, program guide, reproducible masters), Prentice-Hall Media

IX. FORMING (C.)

Estimated Time: 6-9 hours

MAJOR OBJECTIVE: To gain knowledge and skills related to forming and to the use, care, and maintenance of tools and equipment applicable to various forming processes in woodwork.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Integrate instruction in forming throughout other modules in the woodwork area of study. Make students aware of the relationship of forming to safety, measurement, consumerism, materials, design and construction of products, fastening, and mass production.	
A. METHODS OF FORMING WOODS The student should be able to:		
1. define forming;	Discuss, using illustrations and demonstrations, the need to use forming processes to shape wood materials for the manufacture of products and components. Have students define forming.	FORMING: Rearranging the shape of wood material
2. identify methods of forming wood.	Point out that wood and wood products must have certain shapes and sizes to be useful to individuals and industries. Point out	METHODS OF FORMING 1. Bending/stretching 2. Laminating

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	that requisite shapes and sizes are achieved through these forming operations: bending and laminating.	
B. BENDING The student should be able to:		
1. define bending;	Discuss bending as a forming process in woodwork, and have students define it.	BENDING: The process of clamping wood into a mold until it takes the desired shape
2. recognize the relationship of the condition and type of woods to the bending process;	Point out that these conditions are requisite for successful bending: a) Wood should be straight-grained and free from bad spots. b) Air-dried lumber with a moisture content of about twelve to fifteen percent is best. c) Wood should be water softened by steaming or soaking to aid with the bending/stretching process. Explain that hardwoods including oak, maple, elm, ash, and walnut are among the best woods for bending.	Basic Industrial Arts Woodworking, McKnight Publishing, Chapter 7

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
3. describe the techniques of using forms and clamps for bending wood;	Have students prepare research reports on the preparation of wood for bending. Acquaint students with the forms and clamps.	
4. describe the kerfing method of bending wood;	Ask students to define kerfing. Emphasize that the kerfs must be cut across the grain on the inside of the wood to be bent, that the number and depth of the kerfs needed depend on the thickness of the wood and the radius of the curve, and that the kerfed wood should be placed in a form of desired shape.	KERFING: The process of cutting slots in wood with the blade of a saw Basic Industrial Arts Woodworking, McKnight Publishing, Chapter 7
5. bend wood materials;	Acquaint students with the tools, materials, and equipment necessary for bending wood. Demonstrate the kerfing process and the steps for using forms and clamps to bend wood. Provide students with opportunities to practice both bending methods on scrap stock of the kind to be bent for use in products/projects. Emphasize safety precautions.	Forming and Shaping Tools (colour filmstrips, cassettes, study guide), McIntyre Educational Media
C. LAMINATING		
The student should be able to:		
1. define laminating;	Have students discuss and define laminating, a process of forming.	LAMINATING: The process of forming by gluing several thin layers of wood stock together

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
2. recognize the importance of the laminating process;	Have students prepare reports and displays emphasizing these aspects of the laminating process: a) Laminated wood is widely used in the building industry to make structural members. b) Laminated beams are often used in large buildings because they are very strong and can span long distances. c) Laminated beams are very resistant to fire. d) Laminated material is widely used in sporting goods and furniture industries. e) Veneers are used to make laminated products such as tennis rackets and chairs. Point out and have students discuss and list these advantages of glued laminated wood: a) Wood can be bent into shapes without losing strength. b) Wood can be produced in sizes larger than naturally exist. c) Lower grade materials can be used for structural members. d) Large members can be dried more easily since lumber is dried before lamination takes place.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	e) Laminated wood does not check or warp as other large solid members do. f) Laminated wood offers more beauty, strength, insulation, and fire resistance than any other construction material. g) Laminated structural members save money in construction costs.	
3. describe the laminating procedure;	Outline the step-by-step procedure for laminating a wood product.	Basic Industrial Arts Woodworking, McKnight Publishing, Chapter 7 General Woodworking, Second Canadian Edition, SI metric, McGraw-Hill Ryerson, Unit 24
4. laminate a wood product.	Acquaint students with the tools, materials, and equipment necessary for laminating. Demonstrate the step-by-step procedures, and have students practice these on scrap materials before using them on wood products.	

X. FASTENING (C.)

Estimated Time: 10-12 hours

MAJOR OBJECTIVE: To obtain knowledge and skills related to the methods, tools, equipment, and materials applicable to mechanical and adhesion fastening procedures in woodwork.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Integrate instruction in fastening throughout modules in the woodwork area of study. Point out the relationship of fastening to safety, measurement, consumerism, materials, design and construction, forming, finishing, and mass production.	
A. METHODS OF FASTENING WOODS The student should be able to:		
1. define fastening;	Have students discuss and define fastening.	FASTENING: The process of binding, connecting, securing, holding, attaching, and/or affixing one item to another
2. develop an understanding of the importance of fastening;	Use illustrations, samples, and demonstrations to emphasize these concepts: a) Wood products are usually made up of more than one part. b) Selecting the proper wood fastening technique for a given wood product is extremely important.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	c) The time required to assemble wood parts is affected by the fastening method. d) The cost of the assembled product is influenced by the wood-fastening technique used. e) The final strength and safety of a wood product is directly related to the way its parts are fastened together. f) A wood product can be made unsafe or unworkable by using the wrong fastening technique. g) Fastening is one facet of the assembly process of woodwork products. h) Technology, including robotics, is related to fastening of woods.	
3. Identify the methods of fastening.	Emphasize that methods of fastening and types of fasteners have been influenced by needs of people at particular times in history and by technological developments. Have students work in groups to trace the development of fastening methods.	
	Have students identify woodwork products on which mechanical or adhesion fastening has been used.	MECHANICAL FASTENING: Joining of two or more pieces of wood with the help of nails, screws, staples, bolts, and special-purpose mechanical fasteners ADHESION FASTENING: Joining accomplished with the aid of an adhesive

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
B. MECHANICAL FASTENING The student should be able to:		
1. identify methods of mechanical fastening;	Review the definition of mechanical fastening. Discuss and show students examples and illustrations of non-threaded and threaded mechanical fastening used in woodwork.	Fasteners (colour transparency series, overlays, instructor's guide), AIM Educational Aids Nails and Screws, Fastening Wood Parts, Fastening with Dowels (colour filmstrip, cassette, program guide, reproducible masters), Prentice-Hall Media
2. describe the purpose of non-threaded fasteners;	Emphasize these reasons for using non-threaded fastening in woodwork products: aligning parts, strengthening joints, and providing permanent fastening.	Woodworking Tools, Materials, Processes, American Technical Publishers, Units 23, 26
3. recognize the various types of non-threaded fasteners;	Make students aware that non-threaded fasteners of many shapes and sizes are made from different materials with various finishes. Acquaint students with the common non-threaded fasteners by having them participate in activities like these: . preparing labelled panel displays of non-threaded fasteners; . preparing reports and oral presentations on the uses of various types of non-threaded fasteners;	COMMON NON-THREADED FASTENERS 1. Nails 2. Staples 3. Pins 4. Corrugated strips 5. Braces (chevrons) The Basic Book of Woodworking, American Technical Society, Unit 26 General Woodworking, Second Canadian Edition, SI metric, McGraw-Hill Ryerson, Unit 22

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	. preparing research projects on how non-threaded fasteners are manufactured; . participating in identification tests.	Basic Industrial Arts Woodworking, McKnight Publishing, Chapter 8
4. use non-threaded fasteners;	Demonstrate the techniques for using tools. Point out the need to match tools with non-threaded fasteners and to care for and maintain tools. Demonstrate and have students follow the procedures to fasten wood products with various types of non-threaded fasteners. Emphasize safety procedures and precautions.	COMMON TOOLS FOR NON-THREADED FASTENERS 1. Drills 2. Hammers 3. Staplers Claw Hammer and Nail Set, Industrial Arts: Using Nails and Screws (16 mm films), Library, Manitoba Department of Education
5. describe the purpose of threaded fastening;	Discuss these reasons for using threaded fastening in woodwork products: a) The product can be taken apart for repairs and reassembled without damaging any of the parts. b) The threaded parts can be used to make fine adjustments. c) The threaded parts can exert force through movement.	
6. recognize the various types of threaded fasteners;	Point out that threaded fasteners are made in various shapes and sizes, from different materials, and with various finishes. Acquaint students with the common threaded fasteners by having them participate in activities like these:	COMMON THREADED FASTENERS 1. Cap screws 2. Machine bolts 3. Machine screws 4. Set screws

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	- preparing labelled panel displays of threaded fasteners; - preparing reports on the uses of threaded fasteners; - preparing reports or diagrams of types/shapes of heads of threaded fasteners; - preparing research projects on how threaded fasteners are manufactured; - participating in identification tests.	5. Stud bolts 6. Lag screws 7. Carriage bolts Woodworking Tools, Materials, Processes, American Technical Publishers, Units 23, 25 General Woodworking, Second Canadian Edition, SI metric, McGraw-Hill Ryerson, Unit 21 The Basic Book of Woodworking, American Technical Society, Unit 27 Basic Industrial Arts Woodworking, McKnight Publishing, Chapter 8
7. use threaded fasteners;	Acquaint students with the tools necessary for turning and holding threaded fasteners. Point out the need to match tools and threaded fasteners and to care for and maintain tools. Demonstrate and have students follow the procedures to fasten wood products with various threaded fasteners. Emphasize safety precautions.	COMMON TOOLS FOR THREADED FASTENERS Pliers--slip joint, side cutting, long nose Screwdrivers--plain, Phillips head Wrenches--monkey, adjustable, open-end, box, socket Screws, Screwdrivers (16 mm films), Library, Manitoba Department of Education

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
8. identify the various types of joints;	Point out that the assembled product may be stronger if the parts are joined together in certain ways. Show students examples and illustrations of the various joints. Have students locate the joints in wood products at home, and in the school, and have them make models of the most common wood joints.	COMMON WOOD JOINTS 1. Box finger 2. Butt 3. Dado 4. Dovetail 5. Lap 6. Miter 7. Rabbet 8. Mortise and tenon 9. Tongue and groove 10. Scarf Wood Joints (16 mm film), Library, Manitoba Department of Education Five Simple Wood Joints (filmstrip, cassette), School Services of Canada
9. join wood products with various types of joints;	Acquaint students with the use, care, and maintenance of the tools and equipment for joining wood. Emphasize safety procedures and precautions. Demonstrate and have students use the procedures for assembling wood products with various types of common joints. Have students assess the strengths and weaknesses of each of the joints.	Woodworking Tools, Materials, Processes, American Technical Publishers, Units 15-22 Working with Wood, McKnight Publishing, Chapters 12, 13 General Woodworking, Second Canadian Edition, SI metric, McGraw-Hill Ryerson, Unit 23 The Basic Book of Woodworking, American Technical Society, Unit 24

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
		Producing Dado, Lap, and Rabbet Joints, Producing Mortise-and-Tenon Joints (colour filmstrips, cassettes, program guide, reproducible masters), Prentice-Hall Media Joints (colour transparencies series, overlays), AIM Educational Media Woodworking: Producing Joints (colour filmstrips series, cassettes, guide, reproducible masters), Prentice-Hall Media
10. identify the types of hinges;	Explain that many types of hinges are used to put doors on cabinets and other pieces of furniture. Have students prepare displays of various common hinges, describing their uses. Point out that hinges are add-on mechanical fasteners, designated as extrinsic fasteners used to hold pieces of furniture together.	COMMON TYPES OF HINGES 1. Butt 2. Surface 3. Semiconcealed 4. Concealed
11. install hinges.	Demonstrate and have students follow the procedures for installing hinges on products/projects. Emphasize safety precautions.	General Woodworking, Second Canadian Edition, SI metric, McGraw-Hill Ryerson, Unit 28 Basic Industrial Arts Woodworking, McKnight Publishing, Chapter 8

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
C. ADHESION FASTENING The student should be able to:		
1. explain the purposes of adhesion fastening;	Review the definition of adhesion fastening, acquainting students with its uses: . putting furniture parts together; . joining two or more boards face to face to give more thickness; . fastening joints where a tight bond is needed between wood parts; . joining the edges of boards for greater width.	
2. identify the classifications of adhesives.	Have students identify and define the various classifications of adhesives.	CLASSIFICATIONS OF ADHESIVES 1. Natural 2. Synthetic: thermosetting thermoplastic
	Have them use adhesive charts to locate this information about each adhesive: name, how to mix, uses, advantages, disadvantages, clamping time, colour, water resistance, strength.	Glues and Clamps (16 mm film), Library, Manitoba Department of Education Basics of Gluing and Clamping (colour filmstrip, cassette), AIM Educational Aids Gluing and Clamping (colour filmstrip, cassette, program guide, reproducible master), Prentice Hall Media

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
		Adhesives and Gluing (colour transparencies series), AIM Educational Aids
3. join woods by the adhesion process.	Emphasize safety precautions requisite for various types of adhesives. Acquaint students with the tools for applying adhesives. Demonstrate and have students follow these steps: a) Surface preparation--Emphasize that all adhesives require clean surfaces to produce full strength bonds. b) Adhesive preparation--Discuss mixing procedures, carrying the adhesive to the work area, and setting up of equipment. c) Adhesive application--Point out the methods of using brushes, rollers, sprays, and dipping, among others. d) Assembly--Show the positioning of materials to be joined and the use of jigs to align them. e) Bond development--Explain reasons for the curing of adhesives, the evaporation of solvents, the application of pressure and/or heat, and other types of bond development.	STEPS TO PRODUCE SOLID BONDED JOINTS 1. Surface preparation 2. Adhesive preparation 3. Adhesive application 4. Assembly 5. Bond development Woodworking Tools, Materials, Processes, American Technical Publishers, Unit 27 Working with Wood, McKnight Publishing, Chapters 14, 15 General Woodworking, Second Canadian Edition, SI metric, McGraw-Hill Ryerson, Unit 27
	Ask students to test the strengths of various types of adhesives and provide them with opportunities to practice using various types of adhesives on scrap materials and then in products/projects.	The Basic Book of Woodworking, American Technical Society, Unit 25

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Acquaint students with the principles of hot-melt gluing and dielectric gluing. Emphasize these principles of dielectric gluing: a) Disturbed molecules cause friction and create heat. b) A high frequency cycle charge agitates the free molecules at such a high speed that friction generates heat, resulting in the glue bond being completed in seconds.	COMMON USES OF HOT-MELT ADHESIVES 1. Edge bonding of veneer 2. Plastic laminating of furniture tops 3. Application of corner blocks, drawer stops, decorative objects

XI. FINISHING (C.) Estimated Time: 3-6 hours

MAJOR OBJECTIVE: To acquire information and skills related to various finishing processes and to perform these processes using tools and equipment with increasing accuracy.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Integrate instruction in finishing throughout other modules in the woodwork area of study. Emphasize the relationship of finishing to safety, careers, consumerism, design and construction, forming, fastening, and mass production.	
A. INTRODUCTION TO FINISHING The student should be able to:		
1. define finishing;	Have students discuss and define finishing.	FINISHING: Surface treatment of woods done to improve the appearance and to protect the surface from deterioration
2. develop an understanding of the importance of finishing;	Use illustrations, samples, and audio-visuals to make students aware of the following purposes for finishing woodwork: . to improve the appearance of the product; . to prevent erosion; . to cover less expensive wood, enhancing its value; . to improve the wearing quality of wood surfaces;	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	. to protect the surface; . to beautify the surface; . to prevent absorption of water.	
	Point out that most wood products manufactured by modern industry require some kind of finishing.	
3. identify categories of wood finishes;	Emphasize that the categories of wood finishes evolved to meet the needs of industrial and technological processes and products.	
	Point out that to achieve the many purposes of finishing pertinent to woodwork, all wood finishing processes may be grouped into three major categories:	
	. addition of material to wood surface by combining process; . removal of material from wood surface by separating process; . giving some mechanical treatment to the wood surface by forming processes.	FINISHING BY COMBINING: Adding materials, generally called finishes, to other materials to achieve desired colour or lasting qualities FINISHING BY SEPARATING: Removing material to obtain desired surface texture FINISHING BY FORMING: Using pressure to obtain desired surface texture
	Show students examples of each category and ask them to identify finishes (sometimes two or more) on wood products used everyday.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
B. ADDING MATERIALS TO SURFACE The student should be able to:		
1. identify the various types of surface coatings;	Acquaint students with the types of surface coatings and have them prepare displays of each. Emphasize these types of coating materials: a) Organic--lacquers, enamels, paints, waxes. b) Inorganic--urethanes, ceramic glazes.	Industrial Arts Woodworking, Second Edition, Revised, Chas. A. Bennett, Units 42-52 Woodworking Tools, Materials, Processes, American Technical Publishers, Units 48-53 General Woodworking, Second Canadian Edition, SI metric, McGraw-Hill Ryerson, Units 48-57 Working with Wood, McKnight Publishing, Chapters 17-29 Basic Industrial Arts Woodworking, McKnight Publishing, Chapter 9 The Basic Book of Woodworking, American Technical Society, Unit 28 SURFACE COATINGS 1. Enamels 2. Fillers

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
		3. Lacquers 4. Oil finishes 5. Paint (oil base, latex) 6. Sealers 7. Shellacs 8. Stains 9. Urethanes 10. Varnishes 11. Waxes
2. develop an understanding of the purpose of each type of surface coating;	Discuss and have students research literature from manufacturers, as well as other sources, to prepare displays, illustrated written reports, and oral presentations on the purpose of each type of coating used on surfaces of woodwork products. Point out that some surface coatings have a buildup feature to protect the wood with a film, while others have a penetrating feature to colour the pores and the surface.	
3. describe the characteristics of coating materials;	Discuss and have students assess and prepare reports on these characteristics: good weatherability, pigmentation clarity and permanence, penetrating qualities, resistance to abrasion, adhesive qualities, sheen and flowability.	
4. recognize the significance of surface preparation;	Emphasize that the wood must be clean no matter what type of finish is applied to the surface. Have students prepare reports on the need for cleaning wood surfaces prior to applying coating. Demonstrate	CLEANING PRODUCTS 1. Alcohol 2. Mineral spirits 3. Turpentine

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	safe procedures for using various cleaning products and give students opportunities to use them. Acquaint students with the need to examine wood carefully prior to finishing to locate and correct defects such as dents, nail holes, and open joints. Demonstrate and have students use the procedures necessary to rectify defects. Have them practice steaming dents and rectifying other surface defects in scrap wood prior to using these smoothing and leveling procedures in their projects.	SMOOTHING AND LEVELING PRODUCTS 1. Stick shellac 2. Plastic wood 3. Glue and sawdust 4. Cabinetmaker's cement 5. Abrasives 6. Steel wool 7. Planes Wood Finishes (16 mm film), Library, Department of Education
5. finish woodwork products by adding material to the surface.	Acquaint students with the various techniques, tools, and equipment for applying lacquers, paints, enamels, waxes, and other coatings. Emphasize safety procedures and precautions. Demonstrate and have students follow the procedures for using and maintaining the tools and equipment for applying coating finishes. Allow students to practice coating small samples of various woods and encourage them to use coating techniques to finish their wood projects.	Staining and Finishing Wood (filmstrip, cassette), School Services of Canada Woodworking: Finishing (filmstrip series, cassettes, guide, reproducible masters), Prentice-Hall Media

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
C. REMOVING MATERIAL FROM SURFACE The student should be able to:		
1. identify various methods of finishing by removing material from the surface;	Acquaint students with sanding and polishing, separation processes used to finish wood products. Show them examples of wood products finished by sanding and polishing, pointing out that these finishes improve the appearance and durability of the products.	Woodworking Tools, Materials, Processes, American Technical Publishers, Unit 47 Working with Wood, McKnight Publishing, Chapter 30 Basic Industrial Arts Woodworking, McKnight Publishing, pp. WW-87-WW-91
2. finish wood products by removing material from the surface.	Demonstrate and have students use the procedures, tools, equipment, and supplies necessary for finishing wood products by sanding and polishing. Emphasize the requisite safety precautions and procedures. Allow students to become increasingly proficient in sanding and polishing techniques by having them practice these techniques on small samples before incorporating them into woodwork products/projects.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
D. MECHANICAL TREATMENT OF WOOD The student should be able to:		
1. identify various mechanical treatment methods of finishing woods;	Point out that wood may be finished by using forming processes such as plasticizing by steaming, laminating, or by relief kerf cutting. Show or have students find wood products finished by mechanical forming processes.	Woodworking Tools, Materials, Processes, American Technical Publishers, Unit 61
2. finish wood with mechanical treatment methods.	Acquaint students with tools, equipment, and supplies necessary for each of the mechanical treatment methods for woods. Demonstrate procedures for finishing woods by mechanical methods, using tools, equipment, and supplies available in the laboratory. Have students use these procedures. Have students prepare reports or displays, about mechanical methods for which tools, equipment, and supplies are not available in the laboratory, or have them visit industries to learn about these methods.	

XII. JIGS AND FIXTURES (C.) Estimated Time: 3 hours

MAJOR OBJECTIVE: To recognize the significance of jigs and fixtures, gaining knowledge and skills related to designing, constructing, testing, and refining jigs and fixtures for use in manufacturing wood products.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	NOTE: Refer to Module XIII, Jigs and Fixtures, in the metalwork area of study	Industrial Arts 7-9: Manufacturing (Metalwork), Module XIII, Jigs and Fixtures Jigs and Fixture Design, Delmar Publishers

XIII. MASS PRODUCTION (C.)

Estimated Time: 10-15 hours

MAJOR OBJECTIVE: To gain an understanding of the principles and influence of mass production; to explain the essential elements of industry; to describe the basic steps in manufacturing product parts and in planning a manufacturing system of mass production; and to apply the principles and procedures to the mass production of products/projects.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	NOTE: Refer to Module XIV, Mass Production, in the metalwork area of study.	Industrial Arts 7-9: Manufacturing (Metalwork), Module XIV, Mass Production Woodworking Tools, Materials, Processes, American Technical Publishers, Unit 63 Constructing and Manufacturing Wood Products, McKnight Publishing, Chapter 15

XIV. ENTERPRISE SYSTEM (C.) Estimated Time: 10-15 hours

MAJOR OBJECTIVE: To develop an understanding of the enterprise system, the various business organizations and their importance to industrial production, the divisions of an industrial organization, the role of management in corporations, and the way corporations are established.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	NOTE: Refer to Module XV, Enterprise System, in the metalwork area of study.	Industrial Arts 7-9: Manufacturing (Metalwork), Module XV, Enterprise System Woodworking Tools, Materials, Processes, American Technical Publishers, Unit 63

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manufacturing

CORE MODULES: Student Orientation, Safety, Careers, Measurement, Design and Construction, Consumerism, Materials, Separation, Forming, Conditioning, Fastening, Finishing, Jigs and Fixtures, Mass Production, Enterprise System

MANUFACTURING

I. STUDENT ORIENTATION (C.)

Estimated Time: 3 hours

MAJOR OBJECTIVE: To explore the relationship of industrial arts to the needs of individuals, industry, and society.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	NOTE: Refer to Common Modules for Module I, Student Orientation. Emphasize the relationship of manufacturing to some of the basic needs of life, such as food, clothing, shelter, transportation, communication, and recreation. Point out that the modules in Manufacturing explain the basic theory and that the projects provide students with opportunities to explore and apply basic skills and principles and to acquire knowledge of the methods used in industry.	Industrial Arts 7-9: Manufacturing (Metalwork, Plastics, Woodwork, Manufacturing), Module I, Student Orientation What Is Manufacturing? (colour filmstrip, cassette), Nelson Canada The Manufacturing Industry, Manufacturing (colour transparencies, overlays, instructor's guide), AIM Educational Aids The World of Manufacturing (transparency series), Nelson Canada Introduction to the World of Manufacturing (filmstrip), Nelson Canada Manufacturing Industry: An Orientation (colour filmstrip, cassette, teacher's manual, reproducible masters), Singer Career Systems

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II. SAFETY (C.)

Estimated Time: 4 hours

MAJOR OBJECTIVE: To develop safety consciousness in the use of tools, machines, and processes, through a wide range of experiences related to the individual and to the production and servicing aspects of hobbies and industries in manufacturing.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	NOTE: Refer to Common Modules for Module II, Safety. Emphasize the following: a) Students studying the basics of manufacturing must learn safety precautions. b) The right way to do a job is the safe way. c) Safety precautions are protection against injury. d) Safety is a matter of common sense and good judgment. e) Applying safety precautions in all laboratory activities is essential to making them a part of regular work habits. Discuss and have students prepare posters about six major safety rules to be observed during study of manufacturing.	Industrial Arts 7-9: Manufacturing (Metalwork, Plastics, Woodwork, Manufacturing), Module II, Safety Manufacturing: A Basic Text for Industrial Arts, McKnight Publishing, Chapter 4 Introduction to Manufacturing, Delmar Publishers, Units 6-8 Materials Processing, Delmar Publishers, Units 11-14 Manufacturing: Material Processing, Management, Careers, Goodheart-Willcox, Chapter 20 The World of Manufacturing, McKnight Publishing, Reading 29 MAJOR SAFETY RULES 1. Always dress correctly for the job 2. Follow directions 3. Practice good shop housekeeping

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
		4. Learn to use tools and machines correctly 5. Avoid "clowning" 6. Report EVERY accident Safety (series colour filmstrips, cassettes, teacher's manual, reproducible masters), Singer Career Systems

III. CAREERS (C.)

Estimated Time: 3 hours

MAJOR OBJECTIVE: To gain information about the general occupational characteristics of a variety of career fields and to match interests, abilities, likes, dislikes, and values to characteristics of various careers.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	NOTE: Refer to Common Modules for Module III, Careers.	Industrial Arts 7-9: Manufacturing (Metalwork, Plastics, Woodwork, Manufacturing), Module III, Careers
	Integrate career instruction throughout the Manufacturing area of study by familiarizing students with many careers, thereby offering them a basis on which to make choices, and by encouraging them to evaluate themselves in relation to various career opportunities and goals. Point out that a knowledge of career opportunities in manufacturing will aid students in determining future educational, vocational, and life skill endeavours.	Careers: An Overview, Prentice-Hall Where Do You Fit In? (colour filmstrip, cassette, teacher's manual, reproducible masters), Singer Career Systems
	Create an awareness of occupational families related to manufacturing.	Employment and Occupations in Manufacturing (filmstrip), Nelson Canada
	Prepare students for study in advanced vocational and technical programs in manufacturing by providing them with occupational information and exploratory experiences directly related to current practices in industry and by acquainting them with programs available in secondary schools, community colleges, and universities.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Develop and acquire various display materials for the laboratory or classroom that provide information about occupations related to manufacturing. Allow each student to prepare a file of personalized occupational information including data on personal interests, aptitudes, and achievements.	
	Emphasize that students should be well informed about all aspects of a career, from educational requirements and employment opportunities to work duties and conditions in the environment.	
	Make students aware that even though interests, attitudes, and work values are important factors in making career decisions, they should also consider the importance they place on change, risk taking, and helping others.	Manufacturing: A Basic Text for Industrial Arts, McKnight Publishing, Chapters 4, 10
	Involve students in research activities to develop their awareness of manufacturing careers. Point out that the demand for workers in any occupation depends on consumer needs and that many are employed in these job categories:	Introduction to Manufacturing, Delmar Publishers, Unit 2 Materials Processing, Delmar Publishers, Unit 18 Manufacturing: Material Processing, Management, Careers, Goodheart-Willcox, Chapters 33, 34
	a) Unskilled workers, often with little education, are involved in loading and unloading equipment, trucking raw	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	materials, cleaning factory and office areas, removing snow, cleaning windows, and cutting grass. b) Semiskilled workers, with some skills and education, operate machines, work on assembly lines, handle material, and operate power trucks. c) Skilled workers, with apprenticeship or other trade training, include set-up people, millwrights, tool-and-die makers, metal fabricators, electricians, and machinists. d) Technicians provide the connecting link between skilled workers and engineers, and work in areas related to product design, quality control, testing and material evaluation, and production control. e) Supervisors deal with production problems and personnel and are responsible for production and shipping schedules, material inventories, and supervising employees. f) Professional people, generally with college degrees, are employed as engineers, managers, research chemists, presidents, vice-presidents, accountants, and educators. Have students enhance their knowledge of careers in manufacturing by participating in individual and group projects like these:	Manufacturing: Industry and Careers, Prentice-Hall, Unit 7 The World of Manufacturing, McKnight Publishing, Readings 33-38 People and Things: Careers in Manufacturing (16 mm colour film), Westwood Screen

TOPICS AND OBJECTIVE	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	. peparing lists, charts, and displays of occupations made possible directly or indirectly by manufacturing industries; . researching and listing various manufacturing industries in the local community, in Manitoba, and in Canada; . writing an illustrated report on an industry by following an outline like this: history and growth of the industry, number of people employed, kinds of products made, kinds of occupations, types of skills and education needed, salaries and benefits, working conditions; . collecting four or five job advertisements from a newspaper, choosing the most appealing, and then writing a paragraph describing the job requirements and why they are appealing; . reading employment columns in various newspapers and listing opportunities available in manufacturing and manufacturing-related jobs; . observing an employee in a manufacturing industry and developing a job description for that employee; . viewing films and preparing displays about the use and influence of computer technology and robotics on occupations in manufacturing; . attending open-house day at a high school.	

IV. MEASUREMENT (C.)

Estimated Time: 4 hours

MAJOR OBJECTIVE: To procure knowledge and skills related to imperial and SI metric systems of measurement and measuring devices and to apply the knowledge and skills to measurement activities and problems pertinent to manufacturing.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Integrate measurement instruction and applications throughout each module in this area of study. Emphasize that measurement is important in manufacturing industries for these reasons: accurate measurements of various parts must be made, manufactured parts must meet the required specifications, tool-and-die makers and machinists use measuring tools in their daily work. Refer to Module IV, Measurement, in the metalwork, plastics, and woodwork areas of study.	Industrial Arts 7-9: Manufacturing (Metalwork, Plastics, Woodwork), Module IV, Measurement
A. INTRODUCTION TO MEASUREMENT The student should be able to:		
1. define measurement;	Have students discuss and define measurement. Emphasize that measurement is a method used to communicate information about size, shape, distance, weight, and temperature. Have students give examples of measurements used in manufacturing.	MEASUREMENT: A method of communicating size, shape, distance, weight, and temperature

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Make students aware that measurement is made by comparing an unknown quantity with a standard or known quantity.	
2. explain the need for measurement;	Make students aware of the relationship between good workmanship and accurate measurements. Have them identify the ways in which measurement applies to various aspects of manufacturing related to metalwork, plastics, and woodwork.	
3. recognize the need for standards;	Explain that standards for measuring in manufacturing have developed over the years and have been agreed upon by people/organizations such as ISO, ANSI, and CSA, with representation from many industries. Indicate that these standards are the same throughout the world and aid in communicating information pertinent to manufacturing measurements.	ISO: International Organization for Standardization ANSI: American National Standards Institute CSA: Canadian Standards Association
	Inform students that published standards define and allow measurement of length, volume, area, weight, time, temperature, and other values.	Standard Measurement (16 mm colour film), Library, Manitoba Department of Education
4. identify the basic types of quantity measurement;	Identify and discuss the basic kinds of quantity measurement. Have students prepare charts, posters, displays, or reports about the basic types of quantity measurement.	BASIC TYPES OF QUANTITY MEASUREMENT 1. Length 2. Mass 3. Time 4. Temperature

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
		5. Electric current 6. Amount of substance 7. Light intensity Metric System (16 mm colour film), Library, Manitoba Department of Education
5. list and give application examples of SI metric and imperial units of measurement used in manufacturing.	Explain and have students identify SI metric and imperial units of measurement used in various manufacturing activities. Have students prepare charts for their notebooks or for the classroom to identify SI metric and imperial units of measurement and their applications in industry. Emphasize the following:	Metric System, Metric Measurement I: Measurement and Why We Need Standard Measurement, Metric Measurement II: System and How Is It Used? (16 mm colour films), Library, Manitoba Department of Education

UNITS OF MEASURE

QUANTITIES	SI METRIC UNITS	IMPERIAL UNITS	APPLICATIONS
Length, distance	metre	yard foot, inch	Linear measurements Thickness, width, and length of various materials
	millimetre	foot, inch	Length and width of metal products and buildings
			Layout work and measurements in respect to constructing parts of various products
Area	square millimetre, square centimetre, square metre	square inch, square foot, square yard	Area of parts of various products, and various products and buildings
Volume	cubic millimetre, cubic centimetre, cubic metre	cubic inch, cubic foot, cubic yard	Volumes of various types of stock used in manufacturing
Mass/ Weight	kilogram	pound	Quantity unit of stock used in manufacturing
Temperature	degrees Celsius	degrees Fahrenheit	Heat treating of stock used in manufacturing
Pressure	KPa MPa	p.s.i.	Pressure and stress related to stocks used in manufacturing

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TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
B. MEASURING DEVICES The student should be able to:		
1. identify common measuring tools;	Acquaint students with common tools related to measuring. Point out that the tools are used to measure and mark manufacturing stock. Help students to identify the tools and have them prepare labelled charts, posters, and displays of the common tools.	COMMON MEASURING TOOLS 1. Rules 2. Flexible tapes 3. Dividers 4. Scribers 5. Squares 6. Wire and steel gauges 7. Temperature and pressure gauges
2. use common measuring tools;	Demonstrate the use of common measuring tools and provide students with opportunities to use them. Emphasize the importance of using tools correctly and safely and of keeping them in good working condition in relation to projects and products in manufacturing.	Introduction to Manufacturing, Delmar Publishers, Unit 5 Manufacturing: A Basic Text for Industrial Arts, McKnight Publishing, Topics 1-2
	Demonstrate the procedures for measuring thickness, length, and width of sheet, bar, and other types of stock, and assign similar measuring activities.	Materials Processing, Delmar Publishers, Unit 5
3. recognize the need for precision measuring instruments in manufacturing;	Point out that accurate measurement is essential to the safe mass production of interchangeable parts by discussing the following:	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	a) Every part must be accurately made to the size and shape specified. b) Parts made inaccurately will not fit properly with other parts. c) If inaccurate measurements have been made, finished products can malfunction or wear out sooner than they should. d) Parts manufactured at one location are often assembled with other parts at another location. e) The safety of individuals can be dependent upon accurate measurements; e.g., bicycles, motorcycles, automobiles, tractors, combines, airplanes, space vehicles, food mixers, vacuum cleaners, microcomputers. Emphasize that precision measurement is a fact of life today. Ask students to illustrate this concept by way of posters, displays, reports, experiments, and demonstrations.	
4. identify precision measurement instruments;	Show examples or illustrations of precision measurement instruments. Have students prepare labelled charts, posters, or displays of precision measurement instruments. Discuss the influence of technology on precision measurement; e.g., electronic micrometer.	PRECISION MEASUREMENT INSTRUMENTS 1. Calipers 2. Micrometers 3. Gauge blocks

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Have students use different sizes of cardboard mailing tubes to make a large working model of the hub and thimble of a micrometer.	Measuring Instruments (16 mm film), Library, Manitoba Department of Education
5. use precision measurement instruments;	Demonstrate and have students use the correct procedures for measuring with precision instruments available in the laboratory. Explain the need to care for and maintain these instruments so they will function accurately.	Materials Processing, Delmar Publishers, Unit 5 Introduction to Manufacturing, Delmar Publishers, Unit 5
	Provide students with diagrams of various micrometer settings and ask them to make and record the readings.	Manufacturing: A Basic Text for Industrial Arts, McKnight Publishing, Unit V, Topic 2
	Prepare a transparency, complete with several overlays, that can be used to teach beginning students to read a micrometer or other precision measurement instruments.	
6. develop an understanding of computer-controlled measuring.	Discuss computer-controlled measuring and related equipment, and have students further explore this subject by visiting industries and preparing research reports.	

V. DESIGN AND CONSTRUCTION (C.)

Estimated Time: 5-8 hours

MAJOR OBJECTIVE: To obtain knowledge and skills related to the principles of planning and design and to apply the knowledge and skills to plan, design, and construct manufactured projects and products.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Emphasize planning and design throughout all modules in this area of study. Refer to Module V, Design and Construction, in the metalwork, plastics, and woodwork areas of study.	Industrial Arts 7-9: Manufacturing (Metalwork, Plastics, Woodwork), Module V, Design and Construction
A. PLANNING AND MANUFACTURING The student should be able to:		
1. define planning;	Have students discuss and define planning. Point out that products/projects must be planned before manufacturing takes place. Make students aware that planning involves two important resources, people and things, to meet human needs.	PLANNING: The process of identifying and preparing details to be considered before manufacturing begins
2. develop an understanding of the importance of planning;	Point out, citing examples, that planning for various products/projects begins some time before the actual work commences.	

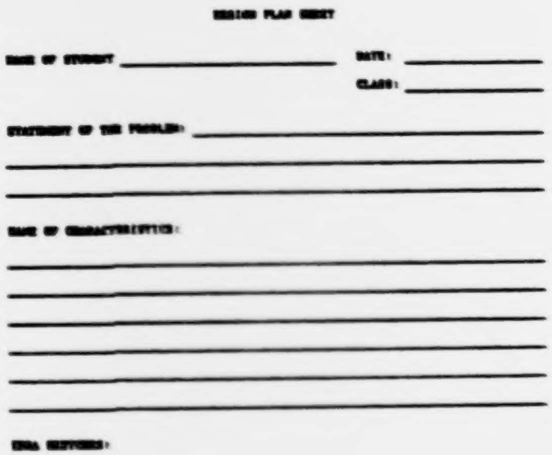
TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
3. identify the components of planning.	Emphasize that planning for manufacturing is a cooperative process, requiring many people to use resources, equipment, and tools effectively to meet the needs of society, business, industry, and individuals. Have students list, discuss, and define the components of planning. Make them aware of the relationship of each component to short-term and long-term planning for manufacturing. Emphasize the importance of scheduling and coordinating for the completion of manufactured projects and products. Point out that improper planning can lead to higher costs and to wasted motion, materials, and effort.	COMPONENTS OF PLANNING 1. Formulating 2. Researching 3. Designing 4. Engineering FORMULATING: The process of deciding what to manufacture to meet needs RESEARCHING: The process of gathering facts to assist with decision-making DESIGNING: The process of developing and creating a plan to meet needs ENGINEERING: The process of adding details to design and of scheduling manufacturing
B. DESIGNING FOR MANUFACTURING The student should be able to:		
1. recognize the importance of design;	Review the definition of designing. Point out that it involves creative planning and original work, rather than copying, to meet societal, industrial, business, and human needs. Encourage students to enhance	Manufacturing: A Basic Text for Industrial Arts, McKnight Publishing, Chapter 7

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	their knowledge about the importance of design to manufacturing by studying catalogues, magazines, and newspapers and by visiting stores and craft shops.	Introduction to Manufacturing, Delmar Publishers, Unit 14
2. identify the requirements for design;	Emphasize that good design in manufacturing means meeting these requirements: strength, function, appearance, materials, cost, and quality.	The World of Manufacturing, McKnight Publishing, Reading 10 Manufacturing: Industry and Careers, Prentice-Hall, Unit 6
3. explain the relationship of design to strength, function, appearance, materials, cost, and quality;	Discuss the influence of design requirements on the design process. Have students consider the following questions: a) Strength--Will the design result in a strong and durable product? b) Function--Does the design fit the purpose for which it was planned? c) Appearance--Do the parts appear to belong together and is the product pleasant to look at, live with, and use? d) Materials--Have the materials been used effectively? e) Cost--Does the cost relate to strength, function, appearance, materials, and quality of the finished product? f) Quality--Is quality an inherent part of the finished product? Indicate that these interrelated requirements apply to all designs.	DESIGN REQUIREMENTS 1. Strength 2. Function 3. Appearance 4. Materials 5. Cost 6. Quality Product Engineering (colour transparency, overlay, instructor's guide), AIM Educational Aids

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
4. describe the basic elements of designing;	Identify and have students define each of the design elements. Point out the relationship of these elements to the design requirements and principles.	LINE: Establishes expression, leads the eye in particular directions, outlines surfaces and contours of form SHAPE: Determines whether an object is pleasing to look at or touch and relies on line, colour, and surface texture SPACE: Volume which an object occupies, including openings COLOUR: Creates special effects such as warmth, cold, distance TEXTURE: Indicates the surface condition, can be felt and seen, and can be related to the pattern
5. explain the principles of design;	Provide students with information about these principles of design: balance, proportion, rhythm, harmony, unity, emphasis, and variety. Make them aware that the principles influence the organization or arrangement of the elements or parts of a manufactured product so that it is pleasing to view. Show them examples, illustrations, and models of various types and styles of manufactured products. Ask them to examine and assess the illustrations and models by answering these questions about the application of the design principles:	PRINCIPLES OF DESIGN 1. Balance 2. Proportion 3. Rhythm 4. Harmony 5. Unity 6. Emphasis 7. Variety *Introduction to Manufacturing*, Delmar Publishers, Unit 14

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	a) Balance--Do the different parts seem to have the same mass or value? Are the parts on each side of the centre line alike in size and shape? b) Proportion--Does the size of one part of a product relate well to the rest? How does the function of an object control the proportion? c) Rhythm--Are the elements or features such as lines, curves, forms, colours, and textures repeated? Do they give the object a pleasing appearance? d) Harmony and unity--Do the parts of an object appear to belong together? e) Emphasis--Does the design have a point of interest? What is the point of interest? f) Variety--Are different materials, shapes, and colours used to give an interesting and lively appearance to the product?	
6. identify steps in the design process.	Explain the steps pertinent to the design process for the development of various manufactured projects/products. Encourage students to think of projects/products as design problems and to use planning sheets to go through these steps: a) Statement of the problem--What is the purpose of the project/product and how will it be used?	STEPS IN THE DESIGN PROCESS 1. Statement of the problem 2. Analysis and research 3. Possible solutions 4. Experimentation 5. Final solution Introduction to Manufacturing, Delmar Publishers, Unit 14

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	b) Analysis and research--Think through the problem. What must the project do? What are the needs or characteristics? What are some of the limitations to be considered? In what ways have others solved similar problems? c) Possible solutions--Develop ideas. What types of charts, sketches, and related labels and notes are necessary to portray the ideas and to determine the materials required to carry out the ideas? Is it necessary to improve the sketches and notes to make a better design? d) Experimentation--Prepare several models or mockups of the design from paper, cardboard, soft wire, styrofoam, plasticene, or other easily manipulated material. What methods of joining and forming materials should be used? What new materials could be used to improve the design? In what ways should the design be changed or improved? e) Final solution--Develop working drawings and a work sheet for the selected solution to the problem and construct the project/product. How should the drawings be used during the construction process? What parts are required? In what order should the operations be completed?	Introduction to Manufacturing, Delmar Publishers, Unit 16

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	 DESIGN PLAN SHEET NAME OF STUDENT ____________ DATE: ________ CLASS: ________ STATEMENT OF THE PROBLEM: ____________ NAME OF CHARACTERISTICS: IDEA SKETCHES:	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES

WORKSHEET

STUDENT ____________________ DATE ____________________

PROBLEM ____________________ CLASS ____________________

A. LIST OF PARTS

# PART NAME	MATERIAL SIZES L	 W	 T	MATERIAL	#REQ'D	COST
1						
2						
3						
4						
5						
6						
7						
					TOTAL	

B. ORDER OF OPERATIONS

STEP	OPERATION	MACHINE OR TOOL REQ'D
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Have students present their models to the class to obtain ideas for improvements and changes. Encourage students to compile notebook records of their own ideas and of ideas collected from periodicals, newspapers, and reference books for projects/products. Have them read and study publications on design to acquire more information about the relationship between projects/products and design. Make students aware that it takes time and practice to acquire skill and knowledge to solve design problems.	
C. PROJECT CONSTRUCTION The student should be able to:		
1. develop an understanding of the importance of sketches, working drawings, and stretchouts/patterns;	Show students examples of sketches, working drawings, and stretchouts/patterns and discuss their importance in the design and construction process. Emphasize that sketches are diagrams portraying ideas related to the possible views, shapes, and sizes of products/projects. Explain that working drawings give all the information needed to make the product and must show the following items: shape of parts, sizes of parts, kinds of material, types of	Manufacturing: A Basic Text for Industrial Arts, McKnight Publishing, Chapter 7 Introduction to Manufacturing, Delmar Publishers, Unit 15

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	finishes, and number of pieces needed for each part. Point out that a stretchout/pattern is a full-size drawing of the product/project on a single plane. Show students examples of stretchouts/patterns of prisms, cylinders, and cones; show them examples or illustrations of products made in these shapes, such as baking pans, letter trays, rectangular and square boxes, planters, toaster ovens, juice containers, cylindrical pencil holders, cylindrical granaries, and silos with cone-shaped roofs.	
2. interpret sketches, working drawings, and stretchouts/patterns;	Explain how to read and extract information from sketches, working drawings, and stretchouts/patterns and provide students with opportunities to read and interpret these.	
3. prepare sketches, working drawings, and stretchouts/patterns;	Point out that diagrams, especially working drawings and stretchouts/patterns, are drawn with certain lines, signs, and abbreviations. Acquaint students with these. Demonstrate and have students use the procedures for preparing sketches, working drawings, and stretchouts/patterns for various manufactured products/projects.	
4. construct and evaluate products/projects.	Have students use the information prepared on design plan sheets, work sheets, sketches, working drawings, and stretchouts/patterns to construct products/	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	projects. Encourage them to assess the construction process, including the use of tools, and the completed products/projects on the bases of planning and design principles and by comparing the input of materials, labour, energy, and other resources to the quality of workmanship, and the time and money expended.	

VI. CONSUMERISM (C.)

Estimated Time: 3 hours

MAJOR OBJECTIVE: To explore the economic system and the economy in relation to manufacturing and consumer awareness.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Integrate instruction in consumerism throughout this area of study, encouraging critical thinking about it and pointing out its application to individuals and business.	
A. ECONOMIC SYSTEMS AND MANUFACTURING The student should be able to:		
1. define economic system;	Explain the term economic system. Emphasize that the term refers to the following: a) The way individual workers and managers, productive organizations such as factories or farms, and government agencies are linked together to form a system, a unit, or an organization. b) The way decisions are made as to how workers, productive organizations, and government agencies will solve the basic economic questions each nation, province, and local community faces.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	List and discuss the basic economic questions. Point out that these questions relate to manufacturing businesses, services, and products and to consumers of these services and products. Make students aware that political, social, religious, and moral systems, which influence economic systems, change from one country to another and within a single country over a period of time. Point out that by using and consuming resources, the various economic systems produce manufactured goods and related services for consumers. Explain that the following economic activities provide resources for manufacturing goods and related services: mining, manufacturing, agriculture, and construction. Make students aware of the need for individuals and businesses to choose goods and services wisely and to use resources effectively during the production of goods and services.	BASIC ECONOMIC QUESTIONS 1. What to produce? 2. How to produce it? 3. Who will receive the services and finished products? 4. How much to produce over a period of time?
2. explain the basic parts of economic systems;	Identify and discuss the basic parts required by economic systems to produce goods and services, inputs, processes, and outputs. Make students aware of these parts in relation to manufacturing businesses, services, and products. Emphasize the following:	BASIC PARTS OF ECONOMIC SYSTEMS 1. Inputs 2. Processes 3. Outputs

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	a) Inputs are resources required to produce goods and services. b) • Processes are work activities required to produce goods and services. c) Outputs are goods and services produced by an economic system. Have students give examples of inputs, processes, and outputs for work activities related to the manufacturing of products and related services.	
3. identify basic types of inputs.	Review the definition of inputs. List and discuss the basic types of inputs. Emphasize that the basic inputs are common to various organizations, such as schools, families, clubs, and businesses. Discuss the relationship among the basic inputs and their application to the production of goods and services for consumption by businesses, organiztions, and individuals.	BASIC TYPES OF INPUTS 1. People 2. Knowledge and skills 3. Industrial resources 4. Utilities 5. Finance
B. MANUFACTURING AND CONSUMERISM The student should be able to:		
1. identify human needs;	Make students aware of the importance of the following human needs: physical, societal, intellectual, and emotional. Relate Maslow's hierarchy of human needs	Looking at the Consumer, Gage Publishing The Confident Consumer, Goodheart-Willcox

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	to the services and products pertinent to manufacturing.	
	Encourage students to identify the basic physical, societal, intellectual, and emotional needs. Point out the relationship between these needs and manufacturing work activities, services, and products.	MASLOW'S HIERARCHY OF HUMAN NEEDS 1. Physical needs 2. Security 3. Love and acceptance 4. Esteem 5. Self-actualization
2. explain how manufacturing meets human needs;	Emphasize that manufacturing and various related services and products are available in different societal and economic systems. Have students compile lists or prepare charts, displays, or written reports about different manufactured products and related services, explaining the need of society, businesses, and individuals for each.	Charts Bulletin board displays
	Ask students to explain how the services and products provided by manufacturing help society and individuals to meet the basic needs of shelter, food, water, and clothing.	*The World of Manufacturing*, McKnight Publishing, Reading 8
3. recognize the relationship between manufacturing and the economy.	Relate various industrial and business activities to national, provincial, regional, and local levels of the economy. Have students investigate the effects of industrial and business activities on employment and businesses related to manufacturing.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Make students aware of the ways in which industries, businesses, and individuals use the services and products of manufacturing to produce other services and goods for various sectors of the economy.	
C. MANUFACTURING AND THE MARKETPLACE		
	Point out why prospective users of the services and products of manufacturing should develop an understanding of the marketplace and its relationship to the economy.	
The student should be able to:		
1. differentiate between needs and wants;	Have students compile lists of services and products of manufacturing desired by individuals. Have them recognize the difference between needs and wants. Make them aware of businesses that need and want services and products of manufacturing.	The World of Business: A Canadian Profile, Wiley Publishers of Canada, Chapter 18 NEEDS: Things required by an individual for basic life and survival WANTS: Things desired by an individual for pleasure and comfort
2. recognize the concept of quality versus cost;	Discuss the following concepts: quality versus cost, influence of demand on supply and cost, state of the economy, financing, and advertising. Relate these concepts to the users and producers of the services and products of manufacturing.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
3. explain the role of supply and demand;	Show students several manufactured products which look alike and have them examine the products carefully to indicate the value of judging products before buying them. Make students aware of the relationship of the services and products of manufacturing, supply and demand, inflation, and credit buying to these concepts: . planning and design; . human needs; . availability and use of resources; . employment; . availability and choice of various services and products. Ask students to list things they would look for in buying specific manufactured products. Have them visit local stores and report on various grades and prices of manufactured articles.	Manufacturing: A Basic Text for Industrial Arts, McKnight Publishing, pp. 15-19 The World of Manufacturing, McKnight Publishing, pp. 19, 46, 48-52, 77-79, 404, 437
4. describe the effects of inflation;	Explain the major causes and effects of inflation. Make students aware of the effect of inflation on individuals, industries, and businesses in general, and on manufacturing businesses and related industries in particular.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
5. identify the positive and negative aspects of credit buying;	Discuss the direct and indirect costs and the advantages and disadvantages of credit to individuals and businesses. Have students compare the costs of manufactured items, purchased on cash and credit terms by individuals and businesses.	Looking at the Consumer, Gage Publishing, Chapter 3
6. explain the purpose and influence of advertising;	Define advertising. Discuss the influence of advertising and promotion on various types of manufactured products and services. Have students collect information about and examples of advertising for displays and reports. Make them aware of the relationship of advertising to cost, supply and demand, and needs and wants pertinent to manufactured products. Discuss advertising psychology and propaganda and point out that some advertising attempts to persuade people to buy regardless of need or ability to pay. Encourage students to study advertisements/sales promotions carefully and to sift out propaganda and false advertising from honest sales effort.	TYPES OF ADVERTISING MEDIA 1. Direct mail 2. Computers 3. Newspapers 4. Periodicals 5. Radio 6. Signs 7. Television Introduction to Manufacturing, Delmar Publishers, Unit 18 Manufacturing: A Basic Text for Industrial Arts, McKnight Publishing, Chapter 12
7. recognize the relationship of sources of materials to the services and products of manufacturing;	Discuss the relationship of material sources to the services and products of manufacturing and to the industrial, business, and individual consumers of these services and products. Ask students to identify the various sources of materials pertinent to manufactured products.	The World of Manufacturing, McKnight Publishing, Reading 77

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Encourage students, individually or in groups, to research information for preparation of displays, charts, scrapbooks, or illustrated reports on the development of manufactured products from various sources, such as metals, plastics, and woods.	
8. explain the consequences pertinent to the consumption of manufactured products;	Have students identify the uses of manufactured products in homes, farms, business and industry, communications, transportation, science, and medicine. Have them discuss the need for continued research related to sources of materials for manufacturing.	
9. justify the need for conservation and cost consideration of materials.	Discuss and have students develop and demonstrate, through research and projects, an understanding of the importance of conservation and cost consideration pertinent to the consumption of materials by industry, business, and individuals. Ask students to consider the relationship of recycling of materials to manufacturing. Have them consider conservation and cost of materials in relation to manufacturing services and products.	

VII. MATERIALS (C.)

Estimated Time: 6 hours

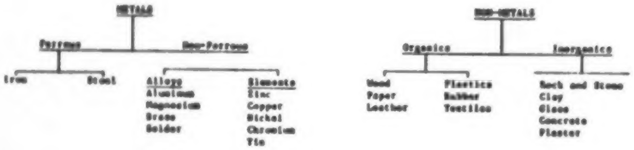
MAJOR OBJECTIVE: To acquire information about the nature, source, classification, processing, and properties of materials, and to apply this information to manufactured projects and products.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Integrate instruction related to materials throughout other modules in this area of study. Emphasize the relationship of materials to safety, measurement, consumerism and conservation, design and construction, forming, fastening, conditioning, finishing, jigs and fixtures, and mass production. Refer to Module VII, Materials, in metalwork, plastics, and woodwork areas of study.	Industrial Arts 7-9: Manufacturing (Metalwork, Plastics, Woodwork), Module VII, Materials
A. INTRODUCTION TO MATERIALS The student should be able to:		
1. explain manufacturing;	Have students discuss and define manufacturing. Emphasize these concepts: a) The development of modern manufacturing is related to materials. b) Product diversification and high-production outputs call for diversity in materials used. c) The development of new and improved materials requires new and improved manufacturing processes.	MANUFACTURING: The process of converting raw materials into products OR The making of products in large quantities OR

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	d) The types of materials used are directly related to the manufacturing processes required to produce a product for a specified function.	The process of coordinating manpower, tools, and machines to convert raw materials into useful products
2. define materials;	Point out that the world is made up of a great variety of materials, that thousands of different materials are used by manufacturing industries, and that adequate types and supplies of materials are needed by manufacturing companies. Have students discuss and define materials.	MATERIALS: Articles necessary for making something OR What things are made from OR Substances of anything manufactured or built
3. develop an awareness of the nature and source of materials;	Discuss the nature of materials by emphasizing the following: a) Materials required for manufacturing are either natural or synthetic. b) Natural materials are available as natural resources, such as metals and woods. c) Synthetic materials are man-made by combining various materials to make new materials, such as plastics.	The Materials of Manufacturing, Raw Materials, Standard Stock, Components, Subassembly, Assembly, Finished Product (colour filmstrips, cassettes, guides), Nelson Canada

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
4. define metals, plastics, and woods;	Show students examples of metal ores and metals, plastics, and woods, and have them discuss and define metals, plastics, and woods.	METALS: Materials derived from earthy substances, characterized by their luster, good electrical and heat conductivity, and heat fusibility OR An opaque, lustrous material, with good heat and electrical conductivity, which is malleable, ductile, heavy, light, and strong PLASTICS: Synthetic materials made up of chains of molecules WOODS: Materials derived from hard, fibrous substances which make up the greater part of the stems and branches of trees beneath the bark
5. recognize the importance of metals, plastics, and woods.	Have students assess and prove this statement: "Metals, plastics, and woods, and products from these materials, are everywhere around us." Ask them to work on group projects (such as posters, displays, or illustrated booklets/reports) to indicate the wide use of metals, plastics, and woods in many manufactured products. Encourage students to develop their knowledge of the use of metals, plastics, and woods by participating in activities like these:	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	. listing products made from metals, plastics, and woods and stating how they are used in everyday life; . checking recent models of motorcycles, automobiles, household appliances, furniture, agricultural implements, ornaments, sports equipment, and musical instruments, and listing the parts that are made from metals, plastics, and woods; . identifying ways in which metals, plastics, and woods are used in construction.	
B. CLASSIFICATIONS OF MATERIALS The student should be able to:		
1. explain the purposes of classification systems;	Point out that classification systems for materials serve these purposes: a) Knowledge of family titles and elements making up the titles assists in identifying materials. b) Information aids learners to look ahead and place the pieces into the whole.	
2. compile a materials classification chart;	Ask students to discuss, study, and use the following chart as a basis for making charts or classroom posters depicting the system of materials classification:	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	 METALS Ferrous Non-Ferrous Iron Steel Alloys Aluminum Magnesium Brass Solder Elements Zinc Copper Nickel Chromium Tin NON-METALS Organics Inorganics Wood Paper Leather Plastics Rubber Textiles Rock and Stone Clay Glass Concrete Plaster	
3. define metals, non-metals, ferrous, non-ferrous, organics, and inorganics;	Have students discuss and define each of the terms and give examples of materials in each of the classifications.	METALS: A large group of materials, derived from earthy material, characterized by their luster, good electrical and heat conductivity, and heat fusibility NON-METALS: All materials that are not metals, such as woods, plastics, concrete glass FERROUS: Metals having iron as their base metal NON-FERROUS: Metallic materials without iron as their base metal

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
		ORGANICS: Materials being composed of or containing matter of plant or animal origin, and therefore large amounts of carbon INORGANICS: Materials composed of matter having no appreciable amounts of carbon, and therefore materials that are relatively inert (do not react chemically)
4. classify materials.	Encourage students to secure many samples of metals, plastics, and woods and to work in groups to mount and label them according to classification.	
C. PROCESSING MATERIALS		
	Point out that raw materials must be processed to provide material of standard size and quality for use in manufacturing metal, plastics, and wood products.	
The student should be able to:		
1. identify the basic steps in processing metals, plastics, and woods;	Emphasize that processing materials results in changing them according to plan into something useful. Acquaint students with the basic steps for processing metals, plastics, and woods into useful shapes and sizes.	BASIC STEPS FOR PROCESSING METALS 1. Mining 2. Milling 3. Smelting 4. Refining 5. Fabricating

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
2. explain the basic steps in processing metals, plastics, and woods;	Have students work in groups to research and prepare reports, charts, and displays describing the basic steps in processing metals, plastics, and woods.	BASIC STEPS FOR PROCESSING TREES 1. Harvesting 2. Transporting 3. Debarking 4. Cutting 5. Grading 6. Drying 7. Surfacing
3. define standard stock;	Have students discuss and define standard stock in relation to metals, plastics, and woods. Point out that materials are produced in many shapes and sizes and that wholesalers carry a supply, or stock, of different kinds of metals, plastics, and woods in different sizes and shapes.	STANDARD STOCK (METALS): Common shapes and sizes in which metals are manufactured, measured, and sold STANDARD STOCK (PLASTICS): Common shapes, sizes, and forms in which plastics are manufactured, measured, and sold STANDARD STOCK (WOODS): Common shapes, sizes, and forms in which woods, plywoods, and composition boards are manufactured, measured, and sold
4. identify the various forms of common metal, plastics, and wood stock;	Present, discuss, and have students locate illustrations and examples of various forms of common metal, plastics, and wood stock.	Introduction to Manufacturing, Delmar Publishers, Units 3, 4

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
5. explain the relationship of common forms to the ordering of metal, plastics, and wood materials.	Have students refer to stock lists or handbooks of materials from companies that manufacture or sell metals, plastics, and wood materials. Encourage them to use these references to order metal, plastics, and wood materials required for projects. Emphasize the need to describe each item accurately and clearly.	Manufacturing: A Basic Text for Industrial Arts, McKnight Publishing, Topics 26, 27, 28, 29 Materials Processing, Delmar Publishers, Units 1, 2, 3, 4 The World of Manufacturing, McKnight Publishing, Readings 42-44, 46-47 Processing Materials (series colour filmstrips, cassettes, teacher's manual, reproducible masters), Singer Career Systems
D. PROPERTIES AND USES The student should be able to:		
1. explain the classifications of metal, plastics, and wood properties;	Point out that the properties of metals, plastics, and woods help determine the type of material to be chosen for a specific product or job. Explain the classifications of material properties by emphasizing these principles during discussion and by demonstration or experimentation: a) Mechanical properties indicate how materials react to various forces, such as tension (bending) and compression (squeezing).	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	b) Physical properties result from the internal structure of materials, and include density (weight for a given size) and conductivity (ability to carry electricity or transfer heat). c) Chemical properties relate to how materials react upon contact with chemical elements, such as gas or acid.	
2. define the common properties of materials;	Discuss the need to understand the common properties of materials and have students list and define the properties. Have students prepare charts and reports to compare the common properties of metals, plastics, and woods.	COMMON PROPERTIES OF MATERIALS 1. Brittleness: A measure of how easily a material cracks or breaks 2. Ductility: A property that allows a material to be drawn out or stretched without breaking 3. Elasticity: A property that enables a material to be stretched and still return to its original shape and size 4. Hardness: The resistance to penetration or denting 5. Machinability: A property of a material that indicates the ease with which it can be machined while maintaining minimum tool wear, maximum cutting speed, and desired finish 6. Tensile Strength: The ability of a material to withstand a pulling force 7. Compressive Strength: The ability of a material to withstand crushing

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
		8. Impact Strength: The ability of a material to resist fracture from hammering or sudden shock 9. Stress: The result of a force or load aplied to a material
3. select materials, according to properties, for various products;	Show or have students locate products made from metals, plastics, and woods. Ask them to state reeasons, based on properties, why different materials were used in these products. Have students choose materials for their projects/products and explain their choice. Point out that selection of the proper materials for projects/products and giving reasons for the selection are very important functions of industry.	
4. combine materials.	Emphasize that the combining of various materials adds variety to the product appearance and design. Challenge students to research and then to experiment with combining various materials in products, relating these activities to planning and design.	

VIII. SEPARATION (C.) Estimated Time: 6-9 hours

MAJOR OBJECTIVE: To obtain knowledge and skills related to separation processes and to the use, care, and maintenance of hand and power tools applicable to these processes for materials in manufacturing.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Refer to Module VIII, Separation, in metalwork, plastics, and woodwork areas of study. Integrate instruction in separation throughout other modules in this area of study. Make students aware of its relationship to safety, measurement, materials, conservation of materials, planning and design, jigs and fixtures, and mass production.	Industrial Arts 7-9: Manufacturing (Metalwork, Plastics, Woodwork), Module VIII, Separation.
A. METHODS OF SEPARATING MATERIALS The student should be able to:		
1. define separating;	Emphasize that during the process of manufacturing products or components, the various materials used must be separated. Have students discuss and define separating.	SEPARATING: Shaping material by removing portions of it
2. identify methods of separating materials;	Hold a "brainstorming" session during which students identify the various methods of separating.	METHODS OF SEPARATING 1. Shearing 2. Chip removal 3. Thermal cutting

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
		4. Flame/arc cutting 5. Chipless machining 6. Induced fracturing
3. describe the methods of separating materials.	Discuss the basic principles related to each of the separating processes by emphasizing the following: a) Materials can be cut to the desired shape. b) Holes can be cut into pieces of materials. c) Unwanted portions can be removed from the surface of materials. d) Notches or pieces of material can be cut from the ends or edges of materials. Point out the importance of safety precautions and procedures pertinent to each separation method. Ask students to define each of the separating methods. Have students identify other processes of separating and match these to various materials. Acquaint students with chipless machining, flame cutting, thermal cutting, and induced fracturing, and have them name materials which can be separated by these methods.	Shearing, Chip Removing, Separating by Other Processes, Separating Processes in Manufacturing (colour filmstrips, cassettes), Nelson Canada SHEARING: A method of cutting without producing waste in the form of chips or meltings CHIP REMOVAL: A cutting or separating process (such as chipping, sawing, filing, grinding, boring, shaping, turning, smoothing) during which chips of materials are removed THERMAL CUTTING: A process of causing plastics materials to separate by melting the material along a separation line FLAME/ARC CUTTING: A metal cutting process done with a flame or an arc cutting torch CHIPLESS MACHINING: A separating process during which no chips are removed, as in chemical milling (etching), electrical discharge machining, and laser machining

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Acquaint students with these concepts: a) In shearing, standard stock is separated by a tool harder than the stock itself, and no material is lost in the form of small chips. b) In chip removal, standard stock is separated by cutting away small chips or pieces with a tool that is harder than the stock itself. c) In other separation processes, excess standard stock can be removed by indirect means, such as heat, chemicals, or electric current.	INDUCED FRACTURING: A method of breaking brittle material along desired lines by flexing the material opposite from a scored line Materials Processing, Delmar Publishers, Units 9, 10, 11, 12 Introduction to Manufacturing, Delmar Publishers, Units 6, 7, 8 Manufacturing: A Basic Text for Industrial Arts, McKnight Publishing, Chapter 3, Topics 3-8, 15-17 The World of Manufacturing, McKnight Publishing, Reading 48 Manufacturing: Material Processing, Management, Careers, Goodheart-Willcox, Chapter 8

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
B. HAND AND POWER TOOLS FOR SEPARATING		
The student should be able to:		
1. identify common hand tools for separation of various materials;	Show students examples or illustrations of common hand tools used in the separation process. Have them identify each by name. Give them the names of the separation processes and have them select the hand tools for each.	Industrial Arts 7-9: Manufacturing (Metalwork, Plastics, Woodwork), Module VIII, Separation Hand Tools (series colour filmstrips, cassettes, teacher's manual, reproducible masters), Singer Career Systems
2. use hand tools applicable to separation processes;	Demonstrate procedures for the accurate use of hand tools applicable to separation processes. Provide students with opportunities to practice the separating processes on various materials. Discuss and demonstrate safety checks and proper care and maintenance of hand tools. Acquaint students with the advantages and disadvantages of hand tools.	
3. perform the separation processes with hand tools with an increasing degree of accuracy;	Demonstrate correct use, care, and maintenance of hand tools and point out how this relates to the production of top quality work. Give frequent performance tests covering the hand tools used in the separating process.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
4. identify common power tools for separation of various materials;	Show students examples or illustrations of common power tools for separating processes. Have them identify each tool by name. Give them the names of the separation processes and have them select power tools to use for each. Use visual and audio-visual aids to introduce power tools not available in the laboratory. Have students prepare illustrated research reports on new developments in power tools, and on the influence of technology and robotics on these developments.	Industrial Arts 7-9: Manufacturing (Metalwork, Plastics, Woodwork), Module VIII, Separation Stationary Power Tools, Portable Power Tools (series colour filmstrips, cassettes, teacher's manual, reproducible masters), Singer Career Systems
5. use power tools applicable to separation processes;	Demonstrate procedures for the accurate use of power tools applicable to separation processes. Provide students with opportunities to practice separation processes using available tools and scrap materials. Emphasize safety, and care and maintenance, of power tools. Discuss and demonstrate safety checks for the various power tools. Acquaint students with the advantages and disadvantages of power tools.	
6. perform the separation processes with power tools with an increasing degree of accuracy.	Demonstrate the correct use, care, and maintenance of power tools, and relate this to the production of top-quality work. Give frequent performance tests on the power tools available in the laboratory.	

IX. FORMING (C.) Estimated Time: 6-9 hours

MAJOR OBJECTIVE: To gain knowledge and skills related to forming and to the use, care, and maintenance of tools and equipment applicable to the various forming processes for materials in manufacturing.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Refer to Module IX, Forming, in metalwork, plastics, and woodwork areas of study. Integrate instruction in forming throughout modules in this area of study. Make students aware of the relationship of forming to safety, measurement, consumerism, materials, design and construction of products, fastening techniques, and mass production.	Industrial Arts 7-9: Manufacturing (Metalwork, Plastics, Woodwork), Module IX, Forming
A. METHODS OF FORMING MATERIALS The student should be able to:		
1. define forming;	Discuss, using demonstrations and illustrations, the need to use forming to shape materials for the manufacture of products and components. Have students discuss and define forming.	FORMING: Rearranging the shape of materials OR Changing standard stock into a component or product without adding or taking away any material

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
2. identify methods of forming.	Point out that materials and products must have certain shapes and sizes to be useful to individuals and industries. Point out that requisite shapes and sizes are achieved through these forming operations: casting/molding and compressing/stretching.	METHODS OF FORMING 1. Casting/molding 2. Compressing/stretching Forming Processes, Casting or Molding, Forming Processes in Manufacturing (colour filmstrips, cassettes), Nelson Canada
B. CASTING OR MOLDING The student should be able to:		
1. define casting/molding;	Discuss casting/molding as a forming process in manufacturing and have students define it.	CASTING/MOLDING: The melting and pouring of material into a mold to produce an object of desired shape OR Manufacturing process in which industrial material is made liquid, poured or forced into a prepared mold of proper design, and allowed to solidify before being extracted
2. recognize the importance of the casting/molding process;	Encourage students to enhance their understanding of the casting/molding process for forming material by having them participate in activities like these:	Materials Processing, Delmar Publishers, Unit 7 Introduction to Manufacturing, Delmar Publishers, Unit 10

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	. preparing research reports on the history of casting/molding; . listing people and industries connected with casting/molding in the local community and the province; . collecting illustrations and examples of castings/moldings made from various materials for the preparation of labelled charts and classroom displays.	Manufacturing: A Basic Text for Industrial Arts, McKnight Publishing, Chapter 3, Topics 18, 20 The World of Manufacturing, McKnight Publishing, Readings 48-50
3. identify the basic steps used in all casting operations;	Emphasize that these basic steps are necessary for all materials being cast: a) A mold of the proper shape is always produced. b) The material to be cast is prepared for casting. c) The material is poured or forced into the mold cavity. d) The material is allowed or caused to harden. e) The finished item/casting is removed/extracted from the mold.	Manufacturing: Material Processing, Management, Careers, Goodheart-Willcox, Chapter 6
4. explain various casting/molding methods;	Acquaint students with these casting/molding methods: sand casting, shell-mold casting, die casting, permanent-mold casting, investment casting, plaster-mold casting, centrifugal/rotational casting, extrusion, injection molding, compression molding, blow molding, and screening.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Have students research the various casting/molding methods and ask them to compare the methods under these headings: mold material used, types of materials cast, typical products resulting from casting.	
	Show students samples of products formed by various casting/molding methods and ask them to identify the method used for each.	
5. cast/mold various materials.	Acquaint students with the tools, materials, and equipment necessary for various casting/molding methods. Demonstrte casting procedures using the tools, materials, and equipment available in the laboratory. Have students use these procedures. Emphasize safety precautions.	
	Have students tour manufacturing industries to observe casting/molding methods that involve tools, materials, and equipment not available in the laboratory; have them prepare displays and reports on these methods.	
C. COMPRESSING AND STRETCHING		
1. define compressing and stretching;	Discuss compressing and stretching as forming processes in manufacturing and have students define compressing and stretching.	COMPRESSING: Forming/shaping materials by subjecting them to compressive/squeezing forces

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
		STRETCHING: Forming/shaping materials by subjecting them to tensile/stretching forces
2. develop an understanding of the importance of compressing and stretching processes;		
3. identify the basic essentials of all compressing and stretching processes;	Emphasize that these essentials should be considered in the various methods of compressing and stretching: a) A shaping device is used. b) The material forming temperature is established. c) A method of applying force is developed.	
4. explain the various compressing and stretching methods;	Emphasize that both compressing and stretching occur simultaneously in most methods. Acquaint students with these compressing and stretching methods: drawing, forging, spinning, stretch forming, drape forming, explosive forming, brake forming, thermoforming, bending, laminating, and roll forming.	Introduction to Manufacturing, Delmar Publishers, Unit 9 Materials Processing, Delmar Publishing, Unit 6
	Have students describe each of the methods of compressing and stretching and identify materials used in each.	Manufacturing: A Basic Text for Industrial Arts, McKnight Publishing, Chapter 3, Topics 20, 21, 22

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Emphasize the following during discussion and viewing of audio-visuals: a) Drawing--involves forming wire by pulling it through dies; pressing sheet metal to shape with matched tooling. b) Forging--involves forming metals usually at red-hot temperatures with hammering and squeezing forces. c) Spinning--involves forming sheet metals by forcing the rotating metal against a properly shaped male mandrel. d) Stretch forming--involves forming cold sheet metal, plastics, rubber, and textiles by pulling over a male mold. e) Drape forming--involves forming fibreglass and sheet glass (using heat) by allowing the material to sag against a cavity form. f) Explosive forming--involves forming sheet metal into a metal cavity form with an explosive charge. g) Brake forming--involves forming straight line bends on cold sheet metal with brakes and folders. h) Thermoforming--involves forming thermoplastic sheet stock by heating it until plasticized, and by forcing it (with vacuum or compressed air) against a form until cold. i) Bending--involves clamping conditioned material such as wood into a mold until it takes the desired shape.	The World of Manufacturing, McKnight Publishing, Readings 48, 49, 51 Manufacturing: Material Processing, Management, Careers, Goodheart-Willcox, Chapter 7

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	j) Laminating--involves pressing wood layers, with adhesive between the layers, to desired shape with matching female/male forms until the adhesive is cured. k) Roll forming--involves forming hot metal billets and bars into sheet metal, beam, and slab shapes, or embossing the surface of materials with textured roles. Show students samples of products formed by various compressing and stretching methods and ask them to identify the method used for each.	
5. form materials by compressing and stretching methods.	Acquaint students with the tools, materials, and equipment necessary for various compressing and stretching methods. Demonstrate compressing and stretching procedures using the tools, materials, and equipment available in the laboratory. Emphasize safety precautions, and have students use these procedures. Have students tour manufacturing industries to observe stretching/compressing methods that involve tools, materials, and equipment not available in the classroom; have them prepare displays and reports on these methods.	

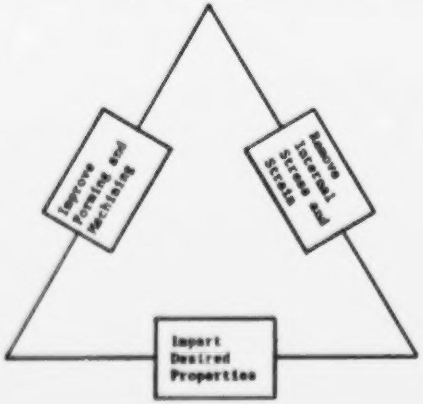
X. CONDITIONING (C.)

Estimated Time: 2 hours

MAJOR OBJECTIVE: To recognize the significance and to gain understanding of the common methods of conditioning, and to apply this understanding to various conditioning processes in manufacturing.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Refer to Module X, Conditioning, in the metalwork area of study. Integrate study of conditioning throughout other modules in this area of study. Emphasize the relationship of conditioning to safety, measurement, consumerism, design and construction, forming, fastening, and mass production.	Industrial Arts 7-9: Manufacturing (Metalwork), Module X, Conditioning
A. INTRODUCTION TO CONDITIONING The student should be able to:		
1. define conditioning;	Have students discuss and define conditioning. Point out that internal changes occurring as the result of the conditioning process do not usually show on the outside of materials as they do in other forming processes known as casting/molding and compressing or stretching.	CONDITIONING: The process of forming standard stock by changing its internal structure without changing its external structure

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
2. develop an understanding of the importance of conditioning;	Use discussions, illustrations, samples, and demonstrations to emphasize these concepts: a) Conditioning allows many different products to be made from many different kinds of standard stock. b) Standard stock can be processed more easily as a result of conditioning. c) Conditioning standard stock gives it a special quality or feature intended to improve the finished product. d) Hardness, a feature that conditioning changes, is important for parts that must last a long time. e) Conditioning standard stock increases its ductility and strength. Ductility refers to stretching and compressing ease and strength to resistance to stress.	
3. describe the internal structure of standard stock;	Use class discussion, diagrams, and experiments to emphasize these points about the internal structure of standard stock: a) The internal structure of standard stock is made up of crystals or cells known as grains. b) Round and widely spaced grains cause materials to be ductile and not very strong. c) Small and flattened out grains result in materials being strong and not very ductile.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
4. explain the reasons why manufacturing industries condition materials;	Have students research, conduct experiments, and study this diagram about the reasons for conditioning materials:  Improve Forming and Machining Remove Internal Stress and Strain Impart Desired Properties REASONS FOR CONDITIONING MATERIALS Emphasize how these points relate to conditioning: a) Conditioning makes materials easier to form or separate. b) Conditioning removes internal stresses and strains which build up during certain forming operations. c) Conditioning can give materials certain properties such as hardness, stiffness, ductility, or strength.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
5. identify common conditioning processes;	Emphasize that methods of conditioning have developed because of the needs of people and industry at particular times in history and because of technological developments.	COMMON CONDITIONING PROCESSES 1. Thermal conditioning 2. Mechanical deforming 3. Chemical reactions 4. Physical conditioning
	Acquaint students with these common conditioning processes: thermal conditioning, mechanical deforming, chemical reactions, and physical conditioning. Have students discuss and define each.	THERMAL CONDITIONING: The process of changing the properties of materials through the addition and withdrawal of heat in various amounts, sequences, or lengths of time
	Make students aware, through discussion and research, that conditioning takes place at various times in the manufacturing cycle. Emphasize these concepts: a) Some conditioning occurs near the beginning of the manufacturing process to get the standard stock ready for mechanical deforming, machining, and other processes. b) Some conditioning, called in-process, happens part way through the manufacturing cycle. c) Some conditioning, called end-process conditioning, occurs at, or near, the end of the manufacturing cycle.	MECHANICAL DEFORMING: The process of changing the properties of materials through temperature change CHEMICAL REACTIONS: The process of changing the chemical properties of materials by inducing a rearrangement of atoms PHYSICAL CONDITIONING: The process of changing the molecular structure of materials by applying direct electrical current to materials

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
6. develop an understanding of the relationship between conditioning and the properties of materials.	Point out that materials have chemical, mechanical, physical, and electrical properties which help to determine the types of materials that should be used or the conditioning that should take place to prepare materials for specific projects. Ask students to identify or review the properties of materials.	Manufacturing: A Basic Text for Industrial Arts, McKnight Publishing, Chapter 3 The World of Manufacturing, McKnight Publishing, Reading 52 Manufacturing: Material Processing, Management, Careers, Goodheart-Willcox, Chapter 9
B. THERMAL CONDITIONING The student should be able to:		
1. explain the importance of thermal conditioning;	Review the definition of thermal conditioning. Emphasize that this heat treating process allows materials to meet these manufacturing requirements: a) Materials must be soft enough to machine. b) Materials must be hard enough to function as intended in the final product.	
2. identify thermal conditioning processes;	Acquaint students with these thermal conditioning processes: annealing, case hardening, hardening, and tempering. Point out that wood can be conditioned by kiln drying to remove extra moisture, making it less likely to warp or shrink after it is	Manufacturing: Material Processing, Management, Careers, Goodheart-Willcox, Chapter 9

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	machined. Discuss each process and have students participate in activities like these: . defining each process; . researching each process; . viewing films/filmstrips about each process; . observing various heat-treating processes in the school shop; . visiting industries to observe and report on heat-treating processes; . preparing charts, bulletin board displays, and illustrated reports on each thermal conditioning process; . experimenting and reporting findings related to the effects of heat treatment on materials; . preparing labelled displays of products which have been heat treated; . researching recent developments, such as flame heardening, induction hardening, and laser and electron beam hardening; . identifying products in homes, schools, and farms that have undergone thermal conditioning.	
3. condition materials by using the thermal conditioning processes.	Emphasize that thermal conditioning includes a number of processes, all of which involve controlled heating and cooling to obtain certain desirable changes in the properties of materials, particularly metals and woods.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Demonstrate and provide students with opportunities to practice processes of thermal conditioning. Review the need to follow safe procedures.	
C. MECHANICAL DEFORMING The student should be able to:		
1. explain the importance of mechanical deforming;	Review the definition of mechanical deforming. Emphasize that the main purpose of this process is to form standard stock into a part or a one-piece product and that stock is often conditioned while being formed.	
2. identify the mechanical deforming processes;	Discuss these mechanical deforming processes: hot-working and cold-working. Have students participate in these activities to enhance their knowledge of mechanical deforming: . defining each process; . researching each process; . viewing audio-visuals about each process; . observing each process in industry and, where possible, in the school shop; . preparing displays and illustrated reports on hot-working and cold-working processes;	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	. experimenting and reporting findings related to the effects of hot-working and cold-working processes on materials; . preparing labelled displays of products which have undergone hot- or cold-working.	
3. condition materials by using the mechanical deforming processes.	Demonstrate and allow students to practice hot-working and cold-working of metals (such as hammering pieces of aluminum or copper). Review the need to follow safe procedures. Make students aware, by having them bend the metals, that the hammered aluminum or copper is stiffer due to the compression of the metal molecules.	
D. CHEMICAL REACTIONS The student should be able to:		
1. explain the importance of chemical reactions;	Review the definition of chemical reactions and emphasize that they bring about a new arrangement of atoms in materials, producing characteristics quite different from the original.	
2. develop an understanding of chemical reaction process in alloying.	Discuss how alloying changes the mechanical and physical properties of base metals combined to produce an alloy. Make students aware that other elements added to metals can change their properties due to chemical reaction.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Explain and have students research these principles: a) Magnesium added to aluminum results in an aluminum alloy which can be welded. b) Copper added to aluminum produces an aluminum alloy with machinability. c) Silicon added to aluminum results in an aluminum alloy capable of being casted. d) Nickel added to steel provides an alloy with increased strength and toughness and aids steel to resist corrosion. e) Chromium adds hardness, toughness, and resistance to wear to steel. f) Manganese used in steel produces a clean metal, adds strength, and helps in heat treating metal. g) Silicon added to steel causes an increase in resiliency. h) Tungsten used with chromium, vanadium, molybdenum, or manganese as additives to steel produces high-speed steel. i) Molybdenum adds toughness and higher strength to steel. j) Vanadium improves the grain of the steel. k) Copper added to gold makes gold harder so it will wear longer. l) Copper and zinc added to silver lowers its melting point for use as silver solder. m) Copper and zinc form brass when combined.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	n) Copper and tin form bronze when combined. Have students make displays using samples to show the different alloys of aluminum and steel. Ask them to survey their homes to identify products conditioned by chemical reaction. Point out that it is possible to change the internal structure of plastics through chemical action in these ways: a) A catalyst, a material which starts chemical action, can be added to a liquid plastic and result in a chemical reaction which changes the liquid to solid. b) The addition of a non-fracture additive causes solid plastics to become ductile as a result of changed internal structure.	
E. PHYSICAL CONDITIONING The student should be able to:		
1. explain the importance of physical conditioning;	Renew the definition of physical conditioning. Point out that only a few physical conditioning processes are used to make products.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
2. condition materials by using a physical conditioning process.	Discuss how a piece of steel becomes a magnetized compass needle. Point out that it must be magnetized before it can be assembled with other compass parts. Have students magnetize metals or metal products, such as the tip of a screwdriver. Emphasize that magnetizing is a physical change brought about by physical conditioning.	

XI. FORMING (C.)　　　　Estimated Time: 10-12 hours

MAJOR OBJECTIVE: To obtain knowledge and skills related to the methods, tools, equipment, and materials applicable to mechanical, adhesion, and cohesion fastening procedures in manufacturing.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Refer to Module X, Fastening, in the plastics and woodwork areas of study, and Module XI, Fastening, in the metalwork area of study. Integrate instruction in fastening throughout modules in this area of study. Point out the relationship of fastening to safety, measurement, consumerism, materials, design and construction, forming, finishing, and mass production.	Industrial Arts 7-9: Manufacturing (Plastics, Woodwork), Module X, Fastening Industrial Arts 7-9: Manufacturing (Metalwork), Module XI, Fastening
A. METHODS OF FASTENING MATERIALS The student should be able to:		
1. define fastening;	Have students discuss and define fastening.	FASTENING: The process of binding, connecting, securing, holding, attaching, or affixing one item to another
2. develop an understanding of the importance of fastening;	Use illustrations, samples, and demonstrations to emphasize these concepts: a) Products are usually made from more than one part.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	b) The proper fastening method must be selected. c) The time required to assemble parts is affected by fastening methods. d) The cost of the assembled product is influenced by the fastening technique used. e) The final strength and safety of a product is directly related to the ways its parts are fastened together. f) A product can be made unsafe or unworkable if the wrong fastening technique is used. g) Fastening is one facet of the product assembling process. h) Technology, including robotics, is related to fastening.	
3. identify the methods of fastening.	Emphasize that methods of fastening and types of fasteners have been influenced by needs of people at particular times in history and by technological developments. Have students work in groups to trace the development of fastening methods.	
	Show or have students collect examples of products made with these fastening methods: mechanical, adhesion, and cohesion. Ask students to prepare definitions of each method.	MECHANICAL FASTENING: Joining of two or more pieces of material with the aid of screws, bolts, rivets, keys, nails, staples, pins, and special purpose mechanical fasteners

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
		ADHESION FASTENING: Joining accomplished by applying a substance as an intermediate capable of holding materials together by surface attachment
		OR
	Point out that all fastening processes are not applicable to all types of materials.	Joining of two similar or dissimilar materials with another material called an adhesive
		COHESION FASTENING: Joining of two or more pieces of similar material by cohesive cementing or sealing
		OR
		Fusing two similar materials together by means of heat or chemical action
		The Combining Processes of Manufacturing (colour filmstrip, cassette), Nelson Canada
		Fastening Materials, Hand Tools, Welding/Brazing (series colour filmstrips, cassettes, teacher's guide, reproducible masters), Singer Career Systems

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
B. MECHANICAL FASTENING The student should be able to:		
1. identify methods of mechanical fastening;	Review the definition of mechanical fastening. Show and have students locate examples and illustrations of these types of mechanical fastening used for various materials: threaded fastening, non-threaded fastening, and seam fastening. Ask students to identify materials which can be fastened by each method.	Industrial Arts 7-9: Manufacturing (Metalwork), Module XI, Fastening Industrial Arts 7-9: Manufacturing (Plastics, Woodwork), Module X, Fastening Materials Processing, Delmar Publishers, Unit 15
2. describe the purposes of threaded fastening;	Discuss these reasons for using threaded fastening for products made from various materials: a) The product can be taken apart for repairs and reassembled without damaging any of the parts. b) The threaded fasteners can be used to make fine adjustments. c) The threaded fasteners can exert force through movement.	Introduction to Manufacturing, Delmar Publishers, Unit 1 Manufacturing: Material Processing, Management, Careers, Goodheart-Willcox, Chapter 10
3. recognize various types of threaded fasteners;	Point out that threaded fasteners are made in many shapes and sizes, from different types of materials, and with various kinds of finishes. Acquaint students with common threaded fasteners by having them participate in these activities:	COMMON THREADED FASTENERS 1. Wood screws 2. Sheet metal screws 3. Machine bolts and screws 4. Plastic screws

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	. preparing labelled panel displays of threaded fasteners; . preparing reports about the uses of threaded fasteners; . preparing reports/diagrams about the types/shapes of heads of threaded fasteners; . preparing research projects about the way threaded fasteners are manufactured; . participating in identification tests.	
4. use threaded fasteners;	Acquaint students with the tools necessary for turning and holding threaded fasteners. Point out the need to match tools to threaded fasteners and to maintain tools effectively. Demonstrate and have students follow the procedures for fastening products with various types of threaded fasteners. Emphasize safety precautions.	COMMON TOOLS FOR THREADED FASTENERS 1. Pliers--slip joint, side cutting, long nose 2. Screwdrivers--plain, Phillips head 3. Wrenches--monkey, adjustable, pipe, open-end, box, socket
5. explain the purpose of non-threaded fastening;	Emphasize and discuss these reasons for using non-threaded fastening: aligning parts, strengthening joints, and providing permanent fastening.	
6. recognize the various types of non-threaded fasteners;	Make students aware that non-threaded fasteners are of many shapes and sizes, and made from different materials with various kinds of finishes. Acquaint students with common non-threaded fasteners by encouraging them to participate in activities like these:	COMMON NON-THREADED FASTENERS 1. Nails 2. Pins 3. Keys 4. Staples 5. Corrugated strips 6. Braces

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	. preparing labelled panel displays of non-threaded fasteners; . preparing reports, oral presentations, and "show and tell" sessions on the uses of various types of non-threaded fasteners; . preparing reports and diagrams of shapes and heads of non-threaded fasteners, especially rivets; . preparing reports and displays of various types of built-in/intrinsic fasteners for plastics and other materials; . preparing research projects on how non-threaded fasteners are manufactured; . participating in identification tests.	7. Rivets 8. Snap fits 9. Press fits
7. use non-threaded fasteners;	Demonstrate techniques for using tools safely. Point out the need to match the tools to the non-threaded fasteners and maintain the tools effectively.	COMMON TOOLS FOR NON-THREADED FASTENERS 1. Drills 2. Pliers 3. Punches 4. Punch and die sets 5. Hammers--ball peen, rivet 6. Rivet sets 7. Pop riveter 8. Staplers
8. recognize common types of sheet metal seams;	Refer to Module XI, Fastening, in the metalwork area of study and have students join sheet metal if equipment is available.	COMMON TYPES OF SHEET METAL SEAMS 1. Butt 2. Lap 3. Corner lap

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
		4. Lap with joggle 5. Folded 6. Grooved
9. join sheet metal with various types of seams;		
10. identify the various types of joints for wood products;	Refer to Module X, Fastening, in the woodwork area of study and have students join wood with various types of joints if equipment is available.	COMMON WOOD JOINTS 1. Butt 2. Box finger 3. Dado 4. Dovetail 5. Lap 6. Miter 7. Rabbet 8. Mortise and tenon 9. Tongue and groove 10. Scarf
11. join wood products with various types of joints.		
C. ADHESION FASTENING		
The student should be able to:		
1. identify the methods of adhesion fastening;	Review the definition of adhesion fastening. Acquaint students with the methods of adhesion fastening: adhesive bonding and	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	soft soldering. Show students examples of each type of adhesive fastening.	Materials Processing, Delmar Publishers, Unit 16 Introduction to Manufacturing, Delmar Publishers, Unit 12 Manufacturing: Material Processing, Management, Careers, Goodheart-Willcox, Chapter 10
2. join materials by the adhesive bonding process;	Refer to Module X, Fastening, in the plastics and woodwork areas of study and Module XI, Fastening, in the metalwork area of study. Have students use the adhesive bonding process to join materials such as metals, plastics, and woods, if equipment is available. Demonstrate, discuss, and have students follow these procedures related to various materials: surface preparation, adhesive preparation, adhesive application, assembly, and bond development.	
3. fasten metal by the soft soldering process.	Refer to Module XI, Fastening, in the metalwork area of study. Have students use the soft soldering process to join metals, if equipment is available. Acquaint students with the importance of soft soldering, conditions for soldering, and equipment, solders, and fluxes for the soldering process.	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
D. COHESION FASTENING The student should be able to:		
1. identify methods of cohesion fastening;	Review the definition of cohesion fastening. Discuss, using visual aids, the methods of cohesion fastening.	Materials Processing, Delmar Publishers, Unit 16 Introduction to Manufacturing, Delmar Publishers, Unit 12
2. join materials with various cohesion fastening methods.	Emphasize safety precautions. Refer to Module X, Fastening, in the plastics area of study and Module XI, Fastening, in the metalwork area of study. Demonstrate and have students use procedures to join materials such metals and plastics with various cohesion fastening methods, if equipment is available.	Manufacturing: Material Processing, Management, Careers, Goodheart-Willcox, Chapter 10 Gas Welding Fundamentals, Arc Welding Fundamentals, Brazing Techniques (colour filmstrips, cassettes, teacher's manual, reproducible masters), Singer Career Systems

XII. FINISHING (C.)

Estimated Time: 3-6 hours

MAJOR OBJECTIVE: To acquire information and skills related to various finishing processes in manufacturing and to perform these processes using tools and equipment with increasing accuracy.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Refer to Module XI, Finishing, in the plastics and woodwork areas of study, and to Module XII, Finishing, in the metalwork area of study. Integrate instruction in finishing throughout other modules in this area of study. Emphasize the relationship of finishing to safety, careers, consumerism, design and construction, forming, conditioning, fastening, and mass production.	Industrial Arts 7-9: Manufacturing (Plastics, Woodwork), Module XI, Finishing Industrial Arts 7-9: Manufacturing (Metalwork), Module XII, Finishing
A. INTRODUCTION TO FINISHING The student should be able to:		
1. define finishing;	Have students discuss and define finishing.	FINISHING: Surface treatment of materials done to protect and improve appearance
2. develop an understanding of the importance of finishing;	Use illustrations, samples, audio-visuals, and research projects to make students aware of the following reasons for finishing materials:	

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	• to improve the appearance of the product; • to prevent corrosion; • to cover less expensive materials, enhancing their value; • to improve the durability of surfaces; • to neutralize chemical reaction; • to protect surfaces; • to beautify surfaces; • to improve electrical conduction; • to improve acoustics. Point out that most products manufactured by modern industry require some kind of finishing.	
3. identify the categories of finishing for materials.	Emphasize that categories of finishing for various materials have evolved to meet the needs of consumers and industrial and technological processes, products, and developments.	
	Point out that all finishing processes may be grouped into three major categories: • addition of material by combining processes; • removal of material by separating processes; • mechanical treatment of material by forming processes.	FINISHING BY COMBINING: Adding materials, generally called finishing, is required on materials not having the desired colour or inherent lasting qualities FINISHING BY SEPARATING: Removing material to obtain desired texture FINISHING BY FORMING: Adding pressure to obtain desired surface texture

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Show students examples from each category and ask them to look at various manufactured products used everyday to identify the many finishes, often two or more.	
B. FINISHING PROCESSES The student should be able to:		
1. identify the classifications of coating materials;	Acquaint students with classifications of combining/coating/adding materials.	CLASSIFICATIONS OF COATING MATERIALS 1. Organic 2. Inorganic 3. Metallic
2. describe the characteristics of various types of coating materials;	Have students prepare research reports and displays about coating materials.	Introduction to Manufacturing, Delmar Publishers, Unit 13
3. identify separation/removing methods of finishing;	Show or have students display examples of materials finished by separation methods, such as buffing, polishing, grinding, sanding, and machining.	Manufacturing: A Basic Text for Industrial Arts, McKnight Publishing, Chapter 3, Topic 23
4. list forming/shaping methods of finishing;	Have students prepare reports and displays on these forming/shaping methods: molding, embossing, knurling.	Materials Processing, Delmar Publishers, Unit 17 The World of Manufacturing, McKnight Publishing, Reading 60

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
5. prepare products for finishing;	Emphasize the need to smooth and clean products before finishing them. Have students prepare research reports on various ways of preparing products for finishing. Have students use procedures, tools, and equipment to prepare products prior to finishing.	Manufacturing: Material Processing, Management, Careers, Goodheart-Willcox Chapter 11 The Combining Processes of Manufacturing (colour filmstrip, cassette), Nelson Canada
6. finish metals, plastics, and woods by using various types of finishing processes.	Emphasize safety precautions and procedures related to finishing metals, plastics, and woods. Acquaint students with the tools, equipment, and supplies necessary for finishing these various materials. Demonstrate and have students use the various procedures for finishing metals, plastics, and woods. Allow students to practice these procedures on each of the materials in sample form, before incorporating them into metalwork, plastics, and woodwork products/projects.	

XIII. JIGS AND FIXTURES (C.)

Estimated Time: 3 hours

MAJOR OBJECTIVE: To recognize the significance of jigs and fixtures, gaining knowledge and skills related to designing, constructing, testing, and refining jigs and fixtures for use in manufacturing products from various materials.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	Refer to Module XIII, Jigs and Fixtures, in the metalwork area of study.	Industrial Arts 7-9: Manufacturing (Metalwork), Module XIII, Jigs and Fixtures
	Integrate instruction in jigs and fixtures throughout other modules in this area of study. Emphasize the relationship of jigs and fixtures to safety, careers, consumerism, design and construction, forming, conditioning, fastening, finishing, and mass production.	
	Point out that manufacturing production lines rely on jigs and fixtures to assist in maintaining identical interchangeable parts and to ensure that each product component meets certain size specifications. Emphasize that jigs and fixtures must be made accurately and must function correctly.	JIG: A device that holds the piece to be machined in position and guides the tool FIXTURE: A device that holds the piece to be machined but does not guide the machine tool Manufacturing: Industry and Careers, Prentice-Hall, p. 63
	Encourage students to participate in activities like these: . building a jig from a drawing; . designing, building, and testing a jig;	The World of Manufacturing, McKnight Publishing, Reading 25 Manufacturing: A Basic Text for Industrial Arts, McKnight Publishing, Topic 25

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	. designing and building jigs and fixtures for specific production jobs to be completed in the industrial arts laboratory.	Introduction to Manufacturing, Delmar Publishers, Unit 21 Materials Processing, Delmar Publishers, Unit 10

XIV. MASS PRODUCTION (C.)

Estimated Time: 10-15 hours

MAJOR OBJECTIVE: To gain an understanding of the principles and influence of mass production; to explain the essential elements of industry; to describe the basic steps in manufacturing product parts and in planning a manufacturing system of mass production; and to apply the principles and procedures to mass production of products/projects.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	NOTE: Refer to Module XIV, Mass Production, in the metalwork area of study. Have students research, discuss, view audio-visuals, take field trips to industries, and use mass production methods in the industrial arts laboratory to gain an understanding of these points: a) Mass production refers to a method of product production. b) Mass production involves manufacturing a high volume of consumer products. c) Mass production means producing many identical products, with only minor differences possible (finishes or colours). d) Mass production means that parts which make up a product are interchangeable. e) Assembly line refers to the putting together of various parts to make a product.	Industrial Arts 7-9: Manufacturing (Metalwork), Module XIV, Mass Production Manufacturing: Industry and Careers, Prentice-Hall, Unit 5 Introduction to Manufacturing, Delmar Publishers, Unit 1 Manufacturing: A Basic Text for Industrial Arts, McKnight Publishing, Chapters 1, 10, 11 Manufacturing: Material Processing, Management, Careers, Goodheart-Willcox, Chapter 26

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	f) Production line refers to the making of a total product, identical to others, by using parts made on the assembly line as well as by making and processing parts and materials. g) Jigs and fixtures have various uses in mass production. h) Use of automated machines, computers, and robotics has influenced mass production methods. i) Operations for mass production must be planned and scheduled. j) The industrial arts laboratory can be organized like a plant for continuous and efficient mass production.	The World of Manufacturing, McKnight Publishing, Readings 26, 27 Basic Manufacturing Processes, McGraw-Hill Ryerson The Tools and Processes of Manufacturing, Research and Development in Manufacturing, Types of Production in Manufacturing, The Final Manufactured Product, Energy Sources for Manufacturing, Making Assemblies or Finished Products (colour filmstrips, cassettes) Nelson Canada Product Cycle, Selecting a Product to Manufacture, Plant and Production Planning, Pilot Run (colour filmstrips, cassettes, teacher's manual, reproducible masters), Singer Career Systems

XV. ENTERPRISE SYSTEM (C.) Estimated Time: 10-15 hours

MAJOR OBJECTIVE: To develop an understanding of the enterprise system, the various business organizations and their importance to industrial production, the divisions of an industrial organization, the role of management in corporations, and the way corporations are established.

TOPICS AND OBJECTIVES	SUGGESTED ACTIVITIES AND NOTES	RESOURCES
	NOTE: Refer to Module XV, Enterprise System, in the metalwork area of study.	Industrial Arts 7-9: Manufacturing (Metalwork), Module XV, Enterprise System Basic Manufacturing Processes, McGraw-Hill Ryerson, Chapter 1 Manufacturing: Industry and Careers, Prentice-Hall, Units 2, 3 The World of Manufacturing, McKnight Publishing, Readings 67-72 Introduction to Manufacturing, Delmar Publishers, Units 17-20 Manufacturing: A Basic Text for Industrial Arts, McKnight Publishing, Chapters 8-12 An Introduction to American Industry (colour transparency series, overlays, guide), AIM Educational Aids

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Canadian Vocational Journal. Canadian Vocational Association, Suite 608, 251 Bank Street, Ottawa, ON K2P 1X3. (quarterly)

Careers. Reed Career Service, Suite 800, 4445 Calgary Trail South, Edmonton, AB T6H 5C3.

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National Safety News. National Safety Council, 444 N. Michigan Avenue, Chicago, IL 60611.

School Shop. Prakken Publications, 416 Longshore Drive, P. O. Box 8623, Ann Arbor, MI 48107. (monthly)

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The Workers' Compensation Act. Manitoba Law Statutes, 1976-1979.

The Workplace Safety and Health Act. Manitoba Law Statutes, 1977-1978.

AUDIO-VISUAL MATERIALS

The following audio-visual materials, published by DCA Educational Products, Warrington, PA 18976, are available from Administration Information Media (AIM) Educational Aids, P. O. Box 86704, North Vancouver, BC V7L 4L2.

1. Colour Transparencies, Overlays, Instructor's Guide

a) Sheet Metal Basics (Edges and Fasteners)
- Types of Edges (SMB-1)
- How to Form Edges (SMB-2)
- Types of Seams-1 (SMB-3)
- Types of Seams-2 (SMB-4)
- How to Make Seams-1 (SMB-5)
- How to Make Seams-2 (SMB-6)
- How to Make Seams-3 (SMB-7)
- Dovetail Seams (SMB-8)
- Nails, Nuts, and Bolts (SMB-9)
- Screws-1 (SMB-10)
- Screws-2 (SMB-11)
- Rivets (SMB-12)
- Rivets, Assembly (SMB-13)
- Rivets, Assembly, Rivet Set (SMB-14)
- Rivets, Assembly, Blind (SMB-15)
- Rivets, Removal (SMB-16)

b) Sheet Metal Hand Tools (and Layout Tools)
- Snips (SHH-1)
- Shears and More Snips (SHH-2)
- Snips and Shears: A Quiz (SHH-3)
- Hammers (SHH-4)
- Mallets (SHH-5)
- Punches (SHH-6)
- Soldering Irons (SHH-7)
- Stakes-1 (SHH-8)
- Stakes-2 (SHH-9)
- Stakes-3 (SHH-10)
- Files (SHH-11)
- Notches and Crimpers (SHH-12)
- Pliers and Screwdrivers (SHH-13)
- Hacksaws and Chisels (SHH-14)
- Miscellaneous Construction Tools (SHH-15)
- Drafting Tools-1 (SHH-16)
- Drafting Tools-2 (SHH-17)
- Measuring Tools (SHH-18)
- Rulers (SHH-19)
- Scribers (SHH-20)
- Gauges (SHH-21)

c) Sheet Metal Pattern Development
- Basic Principles, Box (SHP-1)
- Basic Steps, Box (SHP-2)
- Flared Pan (SHP-3)
- Round Pipe (SHP-4)
- 90° Elbow, Square Throat and Heel (SHP-5)
- 90° Elbow, Curved Throat and Heel (SHP-6)
- Throat and Heel Stretchout Methods (SHP-7)
- Transition Piece (SHP-8)

d) Metric System, Metric Units
   - Think Metric (MET-1)
   - English Measuring Units (MET-2)
   - International System of Metric Units (MET-3)
   - Some Metric Units for Everyday Use (MET-4)
   - The Metric Dollar (MET-5)
   - The Metre (MET-6)
   - The Kilogram (MET-7)
   - Capacity (MET-8)
   - Area (MET-9)
   - Temperature (MET-10)
   - Metric System Prefixes (MET-11)

e) Design and Product Planning (DPPI-28)

2. Filmstrips

a) Unit 1 (SHF010)
   - Straight Cutting with Snips
   - Laying Out and Cutting a Rectangle
   - Laying Out and Cutting a Square

b) Unit 2 (SHF020)
   - Checking Metal for Squareness
   - Laying Out and Squaring Metal by Hand
   - Reading a Rule 1/16 " and 1/32 "

c) Unit 3 (SHF030)
   - Changing the End of a Rectangle to a Semi-Circle
   - Circular Cutting with Snips
   - Spot Welding a Seam

d) Unit 4 (SHF040)
   - Hand Seam: Single Hem
   - Hand Seam: Double Hem
   - Hand Seam: Grooved Lock

e) Unit 5 (SHF050)
   - Parallel Lines
   - Angular Lines
   - Drawing a Pattern

f) Unit 6 (SHF060)
   - Laying Out and Forming a 90 Degree Angle
   - Squaring Metal with the Squaring Shears
   - Bending with Angle Iron and Wooden Blocks

g) Unit 7 (SHF070)
   - Machine Seam: Single Hem
   - Machine Seam: Double Hem
   - Machine Seam: A Wired Edge

h) General Shop Safety

3. Filmstrips, Cassettes

a) Precision Measurement Series (EM101)
   - The Six Inch Rule
   - The Vernier Caliper
   - The English Micrometer
   - The Metric Micrometer

b) Precision Measurement Series (EM102)
   - The Metric Micrometer
   - The Metric Vernier Caliper
   - The Metric Rule

c) Soldering: Introduction and Vocabulary
   Soldering: Miscellaneous
   Soldering: Sheet Metal Techniques

The following audio-visual materials are available from Library, Manitoba Department of Education, 1181 Portage Avenue, Winnipeg, MB R3G 0T3:

1. **Films - 16 mm Colour**

- Band Saw
- Decorative Metalwork
- Drill Presses
- Elements of Hardening
- Elements of Surface Hardening
- Elements of Tempering, Normalizing, and Annealing
- Files
- Files and Filing
- If I Had a Hammer
- Iron and Steel Workers
- Lathe-Chuck Work
- Lathe-Work Between Centres
- Machine Operations
- Measuring Instruments
- Metal Workers
- Metric Measurement I: Measurement and Why We Need Standard Measurement
- Metric Measurement II: What Is the Metric System and How Is It Used?
- Metric System
- Rolling Steel in Selkirk
- Sheet Metal Work
- Simple Developments
- Snips and Shears
- Solder and Soldering
- Standard Measurement
- Standards of Mass
- Steel Rhythm
- Welding

2. **Kits**

- Aircraft Mechanic
- Architectural Drafting
- Career of an Auto Mechanic
- Careers in Graphic Arts: Silkscreening
- The Electrician Kit
- Sheet Metal Working Is . . .

3. **Videorecordings** (Career Awareness Resource Library)

- Carpentry B-2
- Chemical and Plastics Processing F-1
- Concrete Finishing B-3
- Drafting O-4
- Electrical and Electronic Engineering A-8
- Electrical Power, Lighting, and Wire Communucations B-4
- Electronic Products Manufacturing G-6
- General Manufacturing G-8
- Graphic Arts O-6
- Insulating and Roofing Occupations B-6
- Mechanics O-9
- Metal Machining G-11
- Metal Products F-4
- Metal Shaping and Forming G-12
- Photography D-5
- Photographic Processing O-13
- Plastering, Painting and Paper Hanging B-8
- Printing O-14
- Rubber and Plastic Products Manufacturing G-14
- Sheet Metalwork G-15
- Wood Processing F-9
- Wood Products Manufacturing G-19

The following audio-visual materials are available from McIntyre Educational Media, 30 Kelfield Street, Rexdale, ON M9W 5A2:

1. Colour Filmstrips, Cassettes, Study Guide

   a) Metric Measuring Tools Explained
      - The Metric Vernier Caliper
      - The Metric Outside Micrometer
      - The Metric Inside Micrometer
      - The Metric Micrometer Depth Gauge

b) Measuring Tools
  - The Vernier Caliper
  - The Outside Micrometer
  - Inside Micrometers
  - Depth Gauges
  - Dial Indicators
  - Protractors and "JO" Blocks

c) Bench Metal Work
  - Introduction - Tools and Processes
  - Cutting Processes
  - Files and Filing Processes
  - Bending and Shaping
  - Drilling, Reaming, and Threading
  - Peening, Finishing, and Assembly
  - The Forging Process

d) Foundry Work
  - Introduction and Overview
  - Tools and Equipment
  - Preparing and Pouring a One Piece Casting - Part One
  - Preparing and Pouring a One Piece Casting - Part Two
  - Preparing a Split Pattern Casting
  - Foundry (Match Plate Pattern)

e) Sheet Metalwork
  - Introduction and Overview
  - Straight Line Pattern Development
  - Parallel and Radial Line Pattern Development
  - Cutting Methods
  - Drilling, Forming, and Bending - Part One
  - Forming and Bending - Part Two
  - Assembly and Fastening

f) Art Metalwork
  - Introduction and Overview
  - Sinking and Raising
  - Piercing and Tooling Processes
  - Heat Treating, Annealing, and Coloring
  - Metal Spinning - Part One
  - Metal Spinning - Part Two
  - Decorating and Etching
  - Decorative Metalwork--The Making of an Etched Bracelet
  - Copper Enamelling

The following audio-visual materials are available from School Services of Canada, 66 Portland Street, Toronto, ON M5V 2M8:

1. Filmstrips, Cassettes

  a) Metalwork - Hand Tools
    - Measuring and Marking Tools
    - Using Snips and Shears
    - Metal Filing
    - Soldering Methods
    - Welding Techniques
    - Forging Iron

  b) Shop Safety
    - Think Safety
    - General Shop Hazards
    - Hand Saws, Chisels and Files
    - Screwdrivers, Wrenches, Sheet Metal and Welding
    - Grinders, Routers, Power Saws and Jointers
    - Drill Presses and Lathes

The following audio-visual materials are available from Career Aids, 8950 Lurline Avenue, Department R25, Chatsworth, CA 91311:

1. Filmstrips, Cassettes, Instructor's Guide

   Sheet Metal Work
   - Cutting Sheet Metal
   - Riveting and Fastening
   - Soldering
   - Seams and Joints
   - Making Holes in Sheet Metal

2. Filmstrips, Cassettes, Teacher's Guide, Test Material

   Precision Measuring Tools
   - The Metric Vernier Caliper
   - Six-Inch Rule
   - The Vernier Caliper
   - The English Micrometer
   - The Metric Micrometer

The following audio-visual materials are available from Prentice-Hall Media, 1870 Birchmount Road, Scarborough, ON M1P 2J7:

1. Colour Filmstrips, Cassettes, Guide

   a) Safety
      - On Guard!
      - The Safety Program
      - Protecting Your Eyes
      - Using Hand and Bench Tools
      - Operating Power Machines
      - Preparing for Emergencies
      - Wounds, Sprains, Fractures
      - Artificial Respiration
      - Shock, Fainting, Burns

   b) Sheet Metal Work
      - Cutting Sheet Metal
      - Riveting and Fastening
      - Soldering
      - Seams and Joints
      - Making Holes in Sheet Metal

2. Colour Filmstrips, Cassettes, Program Guide, Reproducible Masters

   Safety in the Machine Shop
   - Safety Guidelines
   - Machine Safety

The following visual materials are available from Arnold-Nasco, 58 Dawson Road, Guelph, ON N1H 1A8:

- Rivetting, Soldering and Forming Seams

The following audio-visual materials are available from Workplace Safety and Health Division, Department of Environment and Workplace Safety and Health, 1000 - 330 St. Mary Avenue, Winnipeg, MB R3C 3Z5:

1. Slides

   - Tips for New Employees
   - Safety Attitudes
   - Your Feet Are Your Fortune
   - Guard Your Sight
   - Keep It Clean for Safety's Sake

2. Films - 16 mm Colour

   - Everything to Lose, The Split Second
   - Confined Space Hazards
   - The Sound of Sounds
   - Housekeeping Means Safekeeping
   - We'll See Tomorrow

The following audio-visual materials are available from Film Library, Manitoba Hydro, P. O. Box 815, Winnipeg, MB R3C 2P4:

Films - 16 mm Colour

- It's Happened Before
- The A, B, C's and D's of Portable Fire Extinguishers

The following audio-visual materials are available from Manitoba Telephone System, Public Relations Department, 489 Empress Street, Winnipeg, MB R3G 3G9:

Films - 16 mm Colour

- The Thinking?? Machine
- Incredible Machine

The following audio-visual materials are available from Nelson Canada, Customer Service Department, 1120 Birchmount Road, Scarborough, ON M1K 5G4:

Colour Filmstrips, Cassettes, Student Guide

a) Laying Out and Cutting
   - Straight Cutting with Snips
   - Laying Out and Cutting a Rectangle
   - Laying Out and Cutting a Square

b) Squaring and Rule Reading
   - Checking Metal for Squareness
   - Laying Out and Squaring Metal by Hand
   - Reading a Rule to 1/16 " and 1/32 "

c) Circular Cutting and Spot Welding
   - Changing the End of a Rectangle to a Semi-Circle
   - Circular Cutting with Snips
   - Spot Welding a Seam

d) Hand Seams
   - Hand Seam: Single Hem
   - Hand Seam: Double Hem
   - Hand Seam: Grooved Lock

e) Lines and Patterns
   - Parallel Lines
   - Angular Lines
   - Drawing a Pattern

f) Squaring and Bending
   - Laying Out and Forming a 90 Degree Corner
   - Squaring Metal with Squaring Shearing
   - Bending with Angle Iron and Wooden Blocks

g) Machine Seams
   - Machine Seam: Single Hem
   - Machine Seam: Double Hem
   - Machine Seam: A Wired Edge

The following audio-visual materials are available from Singer Career Systems, 80 Commerce Drive, Rochester, NY 14623:

Colour Filmstrips, Cassettes, Teacher's Manual, Reproducible Masters

Metals
- Metal Coatings
- Sheet Metal Layout

The following audio-visual materials are available from Department of Industrial Education and Technology, Ball State University, Muncie, IN 47306:

1. Colour Filmstrips, Cassettes, Copies of Script

    a) Research and Development
        - Product Design
        - Obtaining Managerial Approval for Developing Products

    b) Production
        - Tooling Design
        - Quality Control
        - Developing Production Methods

    c) Marketing
        - What's In a Name
        - Developing a Marketing System
        - Packaging

    d) General
        - Manufacturing: An Integral Part of Society

2. Transparency Masters

    a) Introduction to Manufacturing and Management
    b) Research and Development
    c) Production
    d) Marketing
    e) Industrial Relations
    f) Financial Affairs
    g) Labor Unions

PLASTICS

TEXTBOOKS

Baird, Ronald, et al. *Industrial Plastics*. South Holland, IL: Goodheart-Willcox, 1982. (Distributed by General Publishing.)

Steele, Gerald L. *Exploring the World of Plastics*. Bloomington, IL: McKnight Publishng, 1977. (Distributed by Nelson Canada.)

REFERENCE BOOKS

Campbell, S. R. *The Confident Consumer*. South Holland, IL: Goodheart-Willcox, 1982. (Distributed by Nelson Canada.)

Canada Department of Manpower and Immigration. *The Canadian Classification and Dictionary of Occupations*. Ottawa, ON: The Department, 1971-1973.

----------. *Careers Manitoba 1981*. Volumes 1, 2, 3, 4. Ottawa, ON: The Department, 1981.

----------. *Creating a Career*. Instructor's Manual. Ottawa, ON: The Department, 1977.

----------. *Creating a Career*. Student's Book. Ottawa, ON: The Department, 1977.

----------. *Training Manual for Canadian Classification and Dictionary of Occupations*. Vol. 1. Ottawa, ON: The Department, 1972.

Canada Handbook. Ottawa, ON: Information Division, Statistics Canada, current year.

Canada Year Book. Ottawa, ON: Information Division, Statistics Canada, current year.

Cherry, Raymond. *General Plastics Projects and Procedures*. 4th ed. Bloomington, IL: McKnight Publishing, 1967.

Cope, Dwight W., and Lee E. Schaude. Plastics. South Holland, IL: Goodheart-Willcox Company, 1977.

Edwards, Lauton. Industrial Arts Plastics. 2nd ed. Peoria, IL: Chas. A. Bennett Company, 1974.

Greenwood, D. P. Plastics Craftwork and Technology. London, Eng.: John Murray Publishers, 1980.

Henderson, Brian L. Exploring Industrial Arts. Scarborough, ON: McGraw-Hill Ryerson, 1983.

Hoffman, Edward G. Jig and Fixture Design. Albany, NY: Delmar Publishers, 1980.

Jambro, Donald J. Manufacturing Processes: Plastics. Englewood Cliffs, NJ: Prentice-Hall, 1976.

Manitoba Department of Education. Safety/Health Guide for Industrial Arts, Vocational, Home Economics, and Business Education. Curriculum Support Series. Winnipeg, MB: The Department, 1981.

----------. The Manitoba Career Guide. Winnipeg, MB: The Department, n.d.

Manitoba Trade Directory. Winnipeg, MB: Sanford Evans Publishing, 1982.

Milby, Robert V. Plastics Technology. New York, NY: McGraw-Hill, 1973.

Miller, W. R., et al. Basic Industrial Arts Plastics. Bloomington, IL: McKnight Publishing Company, 1978.

Murphy, Terry G., et al. The World of Business: A Canadian Profile. Toronto, ON: Wiley Publishers of Canada, 1978.

Olivo, C. Thomas, et al. Basic Blueprint Reading and Sketching. Albany, NY: Delmar Publishers, 1983.

Ontario Federation of Labour. Occupational Health and Safety: A Training Manual. Toronto, ON: Copp Clark Pitman, 1982.

Wood, John C. Looking at the Consumer. Agincourt, ON: Gage Publishing, 1981.

Worthington, Robert M. Careers: An Overview. Englewood Cliffs, NJ: Prentice-Hall, 1977.

PROFESSIONAL BOOKS

Refer to Bibliography for METALWORK.

PERIODICALS

Refer to Bibliography for METALWORK.

MANITOBA LAW STATUTES

Refer to Bibliography for METALWORK.

AUDIO-VISUAL MATERIALS

The following audio-visual materials, published by DCA Educational Products, Warrington, PA 18976, are available from Administration Information Media (AIM) Educational Aids, P. O. Box 86704, North Vancouver, BC V7L 4L2:

1. Colour Transparencies, Overlays, Instructor's Guide

Plastics Technology
- What Are Plastics? (PLA-1)
- Thermoplastic (PLA-2)
- Thermosetting (PLA-3)
- Raw Materials Used to Produce Synthetic Resins (PLA-4)
- Synthetic Resins (PLA-5)
- Homopolymerization (PLA-6)
- Copolymerization (PLA-7)
- Molecular Structure of Plastics (PLA-8)
- Injection Molding (PLA-9)
- Calendering (PLA-10)
- Extrusion (PLA-11)
- Laminating (PLA-12)
- Compression Molding (PLA-13)
- Transfer Molding (PLA-14)
- Casting (PLA-15)
- Blow Molding (PLA-16)
- Thermoforming (PLA-17)
- Rotational Molding (PLA-18)
- Expandable Bead Foam Molding (PLA-19)
- Reinforced Plastic Molding (PLA-20)
- The Plastics Industry (PLA-21)

2. Filmstrips

- General Shop Safety

The following audio-visual materials are available from Copp Clark Pitman, 517 Wellington Street West, Toronto, ON M5V 1G1:

Slides, Cassettes

Educational Plastics Series
- Casting and Encapsulating (812365)
- Coatings (812366)
- Compression and Transfer Molding (812367)
- Polymer Structure (812381)
- Reinforced Plastics (812382)
- Rotational Molding (812384)
- Thermoforming (812389)
- Low and High Pressure Laminating (812377)
- Material Identification (812378)
- Packaging (812379)
- Injection Molding (812373)
- Structure and Chemistry of Plastics (812388)
- Foam Molding (812370)

The following audio-visual materials are available from Library, Manitoba Department of Education, 1181 Portage Avenue, Winnipeg, MB R3G 0T3:

1. Films - 16 mm Colour

- Fibreglass
- If I Had a Hammer
- Magic Molecule
- Measuring Instruments
- Metric Measurement I: Measurement and Why We Need Standard Measurement
- Metric Measurement II: What Is the Metric System and How Is It Used?
- Metric System
- Plastics in Art and Industry
- Standard Measurement
- Standards of Mass
- Thermoplastics

2. Kits

- The World of Acrylics
- The Machinist in the Plastics Molding Industry

3. Videorecordings (Career Awareness Resource Library)

Refer to Bibliography for METALWORK.

The following audio-visual materials are available from Arnold-Nasco Ltd., 58 Dawson Road, Guelph, ON N1H 1A8:

Colour Filmstrips, Cassettes

- Introduction to Plastics
- Thermoforming Plastics
- Casting Plastics

The following audio-visual materials are available from Shell Canada Limited, Education Service, Box 400 Terminal "A", Toronto, ON M5W 1E1:

Films - 16 mm Colour

- Polyolefins
- Prospects for Plastics

The following audio-visual materials are available from Career Aids, 8950 Lurline Avenue, Department R25, Chatsworth, CA 91311:

Colour Filmstrips, Cassettes

Plastics
- Introduction to Plastics
- Separating, Finishing, and Combining
- Casting Plastics
- Thermoforming Plastics
- Coating and Laminating Plastics

WOODWORK

TEXTBOOKS

Groneman, Chris H., et al. General Woodworking. Second Canadian Edition SI metric. Scarborough, ON: McGraw-Hill Ryerson, 1978.

Spence, William P. Woodworking Tools, Materials, Processes. Alsip, IL: American Technical Publishers, 1981. (Distributed by Copp Clark Pitman.)

REFERENCE BOOKS

Campelli, S. R. The Confident Consumer. South Holland. IL: Goodheart-Willcox Company, 1982. (Distributed by General Publishing.)

Canada Department of Manpower and Immigration. The Canadian Classification and Dictionary of Occupations. Ottawa, ON: The Department, 1971-1973.

----------. Careers Manitoba 1981. Volumes 1, 2, 3, 4. Ottawa, ON: The Department, 1981.

----------. Creating a Career. Instructor's Manual. Ottawa, ON: The Department, 1977.

----------. Creating a Career. Student's Book. Ottawa, ON: The Department, 1977.

----------. Training Manual for Canadian Classification and Dictionary of Occupations. Vol. 1. Ottawa, ON: The Department, 1972.

Canada Handbook. Ottawa, ON: Information Division, Statistics Canada, current year.

Canada Year Book. Ottawa, ON: Information Division, Statistics Canada, current year.

Feirer, John L. Industrial Arts Woodworking. Second Canadian Edition. Peoria, IL: Chas. A. Bennett Company, 1977.

Hammond, James J., et al. Woodworking Technology. Bloomington, IL: McKnight Publishing Company, 1980.

Hjorth, Herman, et al. Operation of Modern Woodworking Machines. New York, NY: The Bruce Publishing Company, 1966.

Hoffman, Edward G. Jig and Fixture Design. Albany, NY: Delmar Publishers, 1977.

Hutchings, Gilbert, et al. Working with Wood. Bloomingtion, IL: McKnight Publishing Company, 1982.

Manitoba Department of Education. Safety/Health Guide for Industrial Arts, Vocational, Home Economics, and Business Education. Curriculum Support Series. Winnipeg, MB: The Department, 1981.

----------. The Manitoba Career Guide. Winnipeg, MB: The Department, n.d.

Manitoba Trade Directory. Winnipeg, MB: Sanford Evans Publishing, 1982.

Miller, H. G. Hand and Machine Woodwork. Metric edition. Agincourt, ON: Gage Publishing, 1980.

Miller, W. R., et al. Basic Industrial Arts Woodworking. Bloomington, IL: McKnight Publishing Company, 1978.

Murphy, Terry G., et al. The World of Business: A Canadian Profile. Toronto, ON: Wiley Publishers of Canada, 1978.

Olivo, C. Thomas, et al. Basic Blueprint Reading and Sketching. Albany, NY: Delmar Publishers, 1983.

Ontario Federation of Labour. Occupational Health and Safety: A Training Manual. Toronto, ON: Copp Clark Pitman, 1982.

Rowland, W. Robert. Woodworking Operations Visutext. Scarborough, ON: McGraw-Hill Ryerson, 1980.

Spielman, Patrick E. The Basic Book of Woodworking. Chicago, IL: American Technical Society, 1979.

Wood, John C. Looking at the Consumer. Agincourt, ON: Gage Publishing, 1981.

Worthington, Robert M. Careers: An Overview. Englewood Cliffs, NJ: Prentice-Hall, 1977.

Zook, Wayne H. Constructing and Manufacturing Wood Products. Bloomington, IL: McKnight Publishing Company, 1973.

PROFESSIONAL BOOKS

Refer to Bibliography for METALWORK.

PERIODICALS

Refer to Bibliography for METALWORK.

MANITOBA LAW STATUTES

Refer to Bibliography for METALWORK.

AUDIO-VISUAL MATERIALS

The following audio-visual materials, published by DCA Educational Products, Warrington, PA 18976, are available from Administration Information Media (AIM) Educational Aids, P. O. Box 86704, North Vancouver, BC V7L 4L2:

1. Colour Transparencies, Overlays, Instructor's Guide

a) Wood Technology
- Life of a Tree (WT-1)
- Three Faces of Wood (WT-2)
- Microstructure of Softwood (WT-3)
- Microstructure of Hardwood (WT-4)
- Wood Properties (WT-5)
- Wood Properties (WT-6)
- Wood Properties (WT-7)
- Evaluation of Wood Strength (WT-8)
- Lumber (WT-9)
- Lumber (WT-10)
- Lumber (Wt-11)
- The Manufacture of Lumber (WT-12)
- Veneer (WT-13)
- Plywood (WT-14)
- The Manufacture of Plywood (WT-15)
- Hardboard (WT-16)
- The Manufacture of Hardboard (WT-17)
- Particleboard (WT-18)
- The Manufacture of Particleboard (WT-19)
- Modified Woods (WT-20)

b) Wood Technology Two
- Solid Wood Products (WT-21)
- Chemical and Fibre Products (WT-22)
- Food and Miscellaneous Products (WT-23)
- Annual Growth Sheath (WT-24)
- Cross Grain (WT-25)
- The Wood Fibre (WT-26)
- Cell Wall Pits (WT-27)
- Specific Gravity (WT-28)
- Determination of Moisture Content (WT-29)
- Equilibrium Moisture Content (WT-30)
- January Temperature and Moisture of Interior Woodwork (WT-31)
- July Humidity and Moisture of Interior Woodwork (WT-32)
- Recommended Moisture Content (WT-33)
- Termite Damage in the U.S. (WT-34)
- Forest Regions in the U.S. (WT-35)
- Origins of Wood Species - Eastern Hemisphere (WT-36)
- Origins of Wood Species - Western Hemisphere (WT-37)
- Performance Requirements of Wood (WT-38)
- Processing Requirements for Wood (WT-39)
- Tree and Wood Characteristics (WT-40)
- Softwoods - Comparative Physical Properties (WT-41)
- Hardwoods - Comparative Physical Properties (WT-42)
- Chemical Treatment for Dimensional Stability (WT-43)
- Paper Making (WT-44)

c) Safety in the Wood Shop
- Personal Safety (WB-1)
- Housekeeping and Worker Attitudes (WB-2)
- Hand and Portable Tool Safety (WB-3)
- Basic Machine Safety (WB-4)
- Fire Protection and Materials Handling Safety (WB-5)
- General Shop Safety

d) Cutting Tool Details
- Saw Blade Terminology (WB-6)
- Carbide Tipped Saws (WB-7)
- Bandsaw Blade (WB-8)
- The Jointer (WB-9)
- The Surfacer (WB-10)
- Surface Cutting Action (WB-11)
- Machine Boring Tool Terminology (WB-12)
- Selections of Machine Boring Tools (WB-13)
- Router Bit Terminology (WB-14)
- Selection of Router Bits (WB-15)
- Wood Turning Chisels (WB-16)
- Wood Turning Chisels--Applications (WB-17)

e) Squaring and Building-Up Stock
  - Basic Board Terminology (WB-18)
  - The First Cut (WB-19)
  - Distorted Lumber Problems (WB-20)
  - Machine Squaring to Size (WB-21)
  - Built-Up Stock (WB-22)
  - Squaring Large Panels (WB-23)

f) Adhesives and Gluing
  - Woodworking Glues (WB-24)
  - Tips for Gluing (WB-25)

g) Joints
  - Basic Joints (WB-26)
  - Furniture Joints (WB-27)
  - Furniture and Cabinet Joints (WB-28)
  - Joint Strengtheners (WB-29)

h) Basic Construction Details
  - Box Construction (WB-30)
  - Basic Furniture Case Construction (WB-31)
  - Basic Cabinet Construction (WB-32)
  - Adjustable Shelving (WB-33)
  - Drawer Details (WB-34)
  - Cabinet Drawer Details (WB-35)

i) Fasteners
  - Nails and Nailing (WB-36)
  - Wood Screws (WB-37)
  - Miscellaneous Fasteners (WB-38)

j) Smoothing and Finishing
  - Abrasives (WB-39)
  - Abrasive Grit Sizes (WB-40)

k) Woodworking Hand Tools
  - Measuring Tools (WHT-1)
  - Squares (WHT-2)
  - Compasses, Dividers, Trammels (WHT-3)
  - Marking Tools (WHT-4)
  - Checking and Testing Tools (WHT-5)
  - Hand Saw Nomenclature (WHT-6)
  - Special Purpose Tools (WHT-7)
  - Hand Plane Nomenclature (WHT-8)
  - Common Hand Planes (WHT-9)
  - Special Purpose Planes (WHT-10)
  - Scraping Tools (WHT-11)
  - Chisels (WHT-12)
  - Gouges and Carving Tools (WHT-13)
  - Knives (WHT-14)
  - Files (WHT-15)
  - Forming Tools (WHT-16)
  - Drilling and Boring Tools (WHT-17)
  - Bits and Drills (WHT-18)
  - Screw Drivers (WHT-19)
  - Hammers and Mallets (WHT-20)
  - Nail Sets and Punches (WHT-21)
  - Ripping and Prying Tools (WHT-22)

2. Colour Filmstrips, Cassettes

a) Woodshop Safety
  - Introduction to Woodshop/Carpentry Safety (1B1)
  - Hand Tool Safety (1B2)
  - Power Equipment Safety (1B3)
  - Hand Held Power Tool Safety (1B4)
  - Radial Arm and Band Saw Safety (1B5)
  - Jointer Safety (1B6)
  - Circular Table Saw Safety (1B7)
  - Planer, Disc Sander, Drill Press and Grinder Safety (1B8)
  - Shaper and Scroll Saw Safety (1B9)
  - Wood Lathe Safety (1B10)

b) Woodshop Skills
  - Safe Use of the Dado Set (2B6)

- Safe Use of the Router (2B7)
- Tools for Measuring Wood (2B1)
- Basics of Gluing and Clamping (2B2)
- Computing for a Bill of Materials (2B3)
- How to Make a Face Frame (2B4)
- Hand and Power Sanding (2B5)

The following audio-visual materials are available from Library, Manitoba Department of Education, 1181 Portage Avenue, Winnipeg, MB R3G 0T3:

1. Films - 16 mm Colour

   - Band Saw
   - Basic Layout Tools: Care of Layout Tools
   - Chisels
   - Claw Hammer and Nail Set
   - Glues and Clamps
   - Files and Filing
   - Hammers and Nails
   - The Hand Planes
   - Hand Saws
   - Hand Saws Cross Cut and Rip
   - If I Had a Hammer
   - Industrial Arts: Using Nails and Screws
   - Introduction to Hand Tools
   - Lathe-Face Plate Turning
   - Lathe-Spindle Turning
   - Power Drills
   - The Drill Press
   - Measuring and Layout Tools
   - Measuring and Squaring
   - Measuring Instruments
   - Mensuration
   - Metric Measurement I: Measurement and Why We Need a Standard Measurement
   - Metric Measurement II: What Is the Metric System and How Is It Used?
   - Metric System
   - Planes
   - Portable Electric Sander
   - Scrapers and Abrasives
   - Screws, Screwdrivers
   - Scroll Saw
   - Sharpening Chisels, Plane Irons, and Gouges
   - Standard Measurement
   - Standards of Mass
   - Wood Finishes
   - Wood Joints
   - Wood Turning

2. Kits

   - A Career in Cabinet Making

3. Videorecordings (Career Awareness Resource Library)

   - Refer to Bibliography for METALWORK.

The following audio-visual materials are available from McIntyre Educational Media, 30 Kelfield Street, Rexdale, ON M9W 5A2:

Colour Filmstrips, Cassettes, Study Guide

a) Metric Measuring Tools Explained
   - Refer to Bibliography for METALWORK.

b) Measuring Tools
   - Refer to Bibliography for METALWORK.

c) Woodworking Hand Tools Explained
   - Measuring Tools
   - Marking Tools
   - Cutting Tools
   - Wood Planes
   - Forming and Shaping Tools
   - Files and Finishing Tools

d) Woodworking Explained: Building a Better Bookshelf
  - How to Draw a Working Plan--Part One
  - How to Draw a Working Plan--Part Two
  - Basic Layout Techniques
  - How to Cut Stock
  - Planing
  - Drilling and Boring
  - Sanding
  - Basic Assembly Techniques
  - Finishing

e) Woodworking Machine Operations Explained
  - Operating the Circular Saw
  - Operating the Scroll Saw
  - Operating the Band Saw
  - Operating the Jointer
  - Operating the Drill Press
  - Operating the Woodworking Lathe
  - Faceplate Turning on the Woodworking Lathe

f) The Router
  - Operating the Router
  - Advanced Cuts
  - Plastic Laminates

g) Cabinetmaking Rod Layout and Building Drawers
  - Determining the Width of the Face Frame
  - Determining the Height and Depth of the Face Frame
  - Determining the Size of the Cabinet Parts
  - Fronts and Sides (Drawers)
  - Bottom and Back (Drawers)

The following audio-visual materials are available from School Services of Canada, 66 Portland Street, Toronto, ON M5W 2M8:

Filmstrips, Cassettes

a) Woodworking: Hand Tools (A)
  - Planes and Planing
  - Screwdrivers and Screws
  - Scraping Tools and Abrasives
  - Sharpening of Plane Irons, Chisels, and Gouges
  - Staining and Finishing Wood
  - Five Simple Wood Joints

b) Woodworking: Hand Tools (B)
  - Drilling and Boring
  - Rough Cutting and Smoothing with Chisels
  - Clamps and Adhesives for Woodworking
  - Nails and Hammers
  - Hand Saws and How to Use Them
  - Accurate Measuring and Layout Tools

c) Woodworking: Power Tools
  - Using the Scroll Saw
  - Using the Band Saw
  - Using Power Drills
  - Using Portable Electric Sanders
  - Using the Lathe--Spindlework
  - Using the Lathe--Faceplate Work

d) Woodworking
  - Part I: The World of Woodworking
  - Part II: Woodworking Shop Safety

The following audio-visual materials are available from Prentice-Hall Media, 1870 Birchmount Road, Scarborough, ON M1P 2J7:

1. Colour Filmstrips, Cassettes, Guide

   Safety
   - Refer to Bibliography for METALWORK.

2. **Colour Filmstrips, Cassettes, Program Guide, Reprocible Masters**

a) Safety in Woodworking
  - Hand Tool Safety
  - Machine Tool Safety

b) Woodworking Assembly
  - Using Nails and Screws
  - Gluing and Clamping
  - Producing Dado, Lap, and Rabbet Joints
  - Producing Mortise-and-Tenon Joints

c) Woodworking: Finishing
  - Sandpapers and Sanding
  - Staining and Filling
  - Wood Finishes
  - Repairing Blemishes and Distressing
  - Plastic Laminates
  - Wood Veneering and Techniquing

d) Woodworking: Producing Joints
  - The Rabbet Joint
  - The Dado Joint
  - Lap Joints
  - The Miter Joint

e) Woodworking: Layout
  - Enlarging and Reducing by Squares
  - Proportioned Designs and Geometric Constructions

f) Wood: The Unique Material
  - Physical Properties
  - Lumbering
  - Processed Wood Products

g) Furniture Design Fundamentals
  - Elements of Good Design
  - Furniture Styles

h) Woodworking: Hand Tool Operations
  - Planes and Their Uses
  - Saws and Sawing
  - Fastening Wood Parts
  - Fastening with Dowels
  - Various Woodworking Operations

i) Woodworking: Power Tools
  - The Router--Part 1
  - The Router--Part 2
  - The Electric Hand Drill
  - The Saber Saw
  - The Circular Saw

j) Woodworking: Power Saws
  - Table Saw: Ripping and Crosscutting
  - Table Saw: Squaring, Chamfering, Mitering, and Sawing Rabbets
  - Table Saw: Tapering and Using Dado Head
  - Radial Arm Saw: Ripping and Crosscutting Miter and Bevel Cuts
  - Radial Saw: Using a Dado Head and a Holding Head

k) Woodworking: Power Machines
  - The Surface Planer: Fundamentals
  - The Surface Planer: Operation
  - The Jointer: Fundamentals
  - The Jointer: Operation
  - Bench Sanders
  - Fundamentals of Drill Press
  - Drill Press Operations
  - Fundamentals of the Bandsaw
  - Bandsaw Operations
  - Power Sanders

Murphy, Terry G., et al. The World of Business: A Canadian Profile. Toronto, ON: Wiley Publishers of Canada, 1978.

Olivo, C. Thomas. Basic Blueprint Reading and Sketching. Albany, NY: Delmar Publishers, 1983.

Ontario Federation of Labour. Occupational Health and Safety: A Training Manual. Toronto, ON: Copp Clark Pitman, 1982.

Wood, John C. Looking at the Consumer. Agincourt, ON: Gage Publishing, 1981.

Worthington, Robert M. Careers: An Overview. Englewood Cliffs, NJ: Prentice-Hall, 1977.

Wright, R. Thomas, et al. Manufacturing: Material Processing, Management, Careers. South Holland, IL: Goodheart-Willcox Company, 1976.

PROFESSIONAL BOOKS

Refer to Bibliography for METALWORK.

PERIODICALS

Refer to Bibliography for METALWORK.

MANITOBA LAW STATUTES

Refer to Bibliography for METALWORK.

AUDIO VISUAL MATERIALS

The following audio-visual materials, published by DCA Educational Products, Warrington, PA 18976, are available from Administration Information Media (AIM) Educational Aids, P. O. Box 86704, North Vancouver, BC V7L 4L2:

1. Colour Transparencies, Overlays, Instructor's Guide

   a) An Introduction to American Industry
      - What is American Industry? (IND-1)
      - Mass Production (IND-2)
      - Types of Modern Industry (IND-3)
      - The Manufacturing Industry (IND-4)
      - The Construction Industry (IND-5)
      - The Power and Transportation Industry (IND-6)
      - The Communications Industry (IND-7)
      - Four Tasks of Management (IND-8)
      - The Ladder of Management (IND-9)
      - Typical Company Organization (IND-10)
      - Productivity (IND-11)
      - Gross National Product (IND-12)
      - Seven Aspects of a Successful Company (IND-13)
      - Profit (IND-14)
      - Government and Industry (IND-15)
      - The Five Areas of a Company (IND-16)
      - The Monetary Affairs Area (IND-17)
      - Company Ownership and Capital (IND-18)
      - How a Corporation Secures Capital (IND-19)
      - The Research and Development Area (IND-20)
      - Product Engineering (IND-21)
      - The Production Area (IND-22)
      - Production Planning (IND-23)
      - Industrial Engineering (IND-24)
      - Simple Plant Layout Diagram (IND-25)
      - Plant Engineering (IND-26)
      - Manufacturing (IND-27)
      - Quality Control (IND-28)
      - The Marketing Area (IND-29)
      - Market Research (IND-30)
      - Product Promotion (IND-31)

   - Selling and Servicing (IND-32)
   - Distribution (IND-33)
   - The Industrial Relations Area (IND-34)
   - Employment: Wages; Salaries (IND-35)
   - Job Analysis (IND-36)
   - Training: Employee Services (IND-37)
   - Labor Relations (IND-38)
   - Bargaining Pressures (IND-39)
   - The Union Contract (IND-40)
   - The Grievance Procedure (IND-41)

b) Metric System, Group 1 Metric Units
   - Refer to Bibliogrphy for METALWORK.

c) Metalwork, Plastics, Woodwork Transparencies
   - Refer to Bibliographies for METALWORK, PLASTICS, and WOODWORK

2. Filmstrips

Units 1-7
- Refer to Bibliography for METALWORK

3. Filmstrips, Cassettes

Metalwork, Plastics, Woodwork Filmstrips, Cassettes
- Refer to Bibliographies for METALWORK, PLASTICS, and WOODWORK

The following audio-visual materials are available from Library, Manitoba Department of Education, 1181 Portage Avenue, Winnipeg, MB R3G 0T3:

1. Films - 16 mm Colour

   - Refer to Bibliographies for METALWORK, PLASTICS, and WOODWORK

2. Kits

   - Refer to Bibliographies for METALWORK, PLASTICS, and WOODWORK

3. Videorecordings (Career Awareness Resource Library)

   - Refer to Bibliography for METALWORK.

The following audio-visual materials are available from McIntyre Educational Media, 30 Kelfield Street, Rexdale, ON M9W 5A2:

Colour Filmstrips, Cassettes, Study Guide

- Refer to Bibliographies for METALWORK, PLASTICS, and WOODWORK

The following audio-visual materials are available from School Services of Canada, 66 Portland Street, Toronto, ON M5W 2M8:

Filmstrips, Cassettes

- Refer to Bibliographies for METALWORK and WOODWORK

The following audio-visual materials are available from Prentice-Hall Media, 1870 Birchmount Road, Scarborough, ON M1P 2J7:

1. Colour Filmstrips, Cassettes, Guide

   - Refer to BIBLIOGRAPHIES FOR METALWORK, PLASTICS, and WOODWORK

2. Colour Filmstrips, Cassettes, Program Guide, Reproducible Masters

   - Refer to Bibliographies for METALWORK, and WOODWORK

The following audio-visual materials are available from Workplace Safety and Health Division, Department of Environment and Workplace Safety and Health, 1000 - 330 St. Mary Avenue, Winnipeg, MB R3C 3Z5:

1. Slides

   - Refer to Bibliography for METALWORK.

2. Films - 16 mm Colour

   - Refer to Bibliography for METALWORK.

The following audio-visual materials are available from the Film Library, Manitoba Hydro, P. O. Box 815, Winnipeg, MB R3C 2P4:

Films - 16 mm Colour

- Refer to Bibliography for METALWORK.

The following audio-visual materials, published by McKnight Publishing Company, Bloomington, IL, are available from Nelson Canada, 1120 Birchmount Road, Scarborough, ON M1K 5G4:

1. Colour Filmstrips, Cassettes, Guide

   For Manufacturing: A Basic Text for Industrial Arts
   - What Is Manufacturing?
   - The Materials for Manufacturing
   - The Tools and Processes of Manufacturing
   - Forming Processes in Manufacturing
   - Separating Processes in Manufacturing
   - The Combining Processes of Manufacturing
   - Research and Development in Manufacturing
   - Types of Production in Manufacturing
   - The Final Manufactured Product
   - Energy Sources for Manufacturing

2. Filmstrips

   World of Manufacturing
   - Introduction to the World of Manufacturing
   - Employment and Occupations in Manufacturing
   - Securing Inputs to Manufacturing
   - Raw Materials, Standard Stock, Components, Sub-Assembly, Assembly, Finished Product
   - Forming Processes
   - Casting or Molding
   - Conditioning Material
   - Shearing
   - Chip Removing
   - Making Assemblies or Finished Products
   - Separating by Other Processes
   - Corporations and Their Trademarks
   - Overview of Manufacturing Corporation
   - Manufacturing in the Future
   - Story of Tires
   - The One Big Machine
   - Manufacture of the Telephone

3. Colour Transparencies, Overlays

   World of Manufacturing
   - Set of 87 Overhead Transparencies

The following audio-visual materials are available from Singer Career Systems, 80 Commerce Drive, Rochester, NY 14623:

Colour Filmstrips, Cassettes, Teacher's Manual, Reproducible Masters

a) Manufacturing: People, Processes, and Products
   - Teacher's Introduction
   - Manufacturing Industry: An Orientation
   - Company Ownership and Management
   - Function and Needs of Management
   - Product Cycle
   - Distribution of Income
   - Selecting a Product to Manufacture
   - Organizing an In-School Company
   - Plant and Production Planning
   - Pilot Run
   - Dissolving the Company
   - Where Do You Fit In?

b) Manufacturing Processing Cluster
   i. Stationary Power Tools
      - Using a Drill Press
      - Using a Radial Arm Saw
   ii. Hand Tools
      - Using a Pop Riveter
      - Reading a Micrometer
      - Files: Types and Uses
      - Clamps: Types and Uses
      - Wrenches, Ratchets, and Drivers
      - Sharpening Woodworking Hand Tools
      - Wood Chisels: Care and Uses
      - Screwdrivers: Types and Uses
      - Hammers and Mallets
      - Hand Saws: Types and Uses
   iii. Portable Power Tools
      - The Portable Electric Drill
      - Using a Circular Saw
      - Using a Saber Saw
      - Using a Belt Sander
      - Set-Up and Use a Router
      - Bits and Pieces for Electric Drills
      - How Drill Bits Are Sized
   iv. Processing Materials
      - Common Sheet Metal
      - Abrasives
      - Plastics: Types and Uses
      - Plastics Molding Materials
   v. Fastening Materials
      - Machine Screws
      - Wood Screws
      - Nails
      - Wood Glue and Adhesives
   vi. Safety
      - Storing Hazardous Liquids
      - Fire Extinguishers: Classification and Uses
   vii. Welding/Brazing
      - Gas Welding Fundamentals
      - Arc Welding Fundamentals
      - Brazing Techniques
   viii. Metals
      - Metal Coatings
      - Sheet Metal Layout

The following audio-visual materials are available from Department of Industrial Education and Technology, Ball State University, Muncie, IN 47306:

1. Colour Filmstrips, Cassettes, Copies of Script

   - Refer to Bibliography for METALWORK.

2. Transparency Masters

   - Refer to Bibliography for METALWORK.

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TEXTBOOKS

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Jambro, Donald J. Introduction to Manufacturing. Albany, NY: Delmar Publishers, 1982.

Thode, Bradley R. Materials Processing. Albany, NY: Delmar Publishers, 1982.

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Campbell, S. R. The Confident Consumer. South Holland, IL: Goodheart-Willcox Company, 1982. (Distributed by General Publishing.)

Canada Department of Manpower and Immigration. The Canadian Classification and Dictionary of Occupations. Ottawa, ON: The Department, 1971-1973.

----------. Careers Manitoba 1981. Volumes 1, 2, 3, 4. Ottawa, ON: The Department, 1981.

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----------. Creating a Career. Student's Book. Ottawa, ON: The Department, 1977.

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Canada Handbook. Ottawa, ON: Information Division, Statistics Canada, current year.

Dean, Harvey R. Manufacturing: Industry and Careers. Englewood Cliffs, NJ: Prentice-Hall, 1976.

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Kazanas, H. C., et al. Basic Manufacturing Processes. Scarborough, ON: McGraw-Hill Ryerson, 1981.

Johnson, Harold V. Manufacturing Processes: Metals and Plastics. Peoria, IL: Chas. A. Bennett, 1973.

Lux, Donald G., et al. The World of Manufacturing. Bloomington, IL: McKnight Publishing Company, 1971.

----------. The World of Manufacturing Laboratory Manual. Bloomington, IL: McKnight Publishing Company, 1971.

----------. The World of Manufacturing Teacher's Guide. Bloomington, IL: McKnight Publishing Company, 1971.

Manitoba Department of Education. Safety/Health Guide for Industrial Arts, Vocational, Home Economics, and Business Eduation. Curriculum Support Series. Winnipeg, MB: The Department, 1981.

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